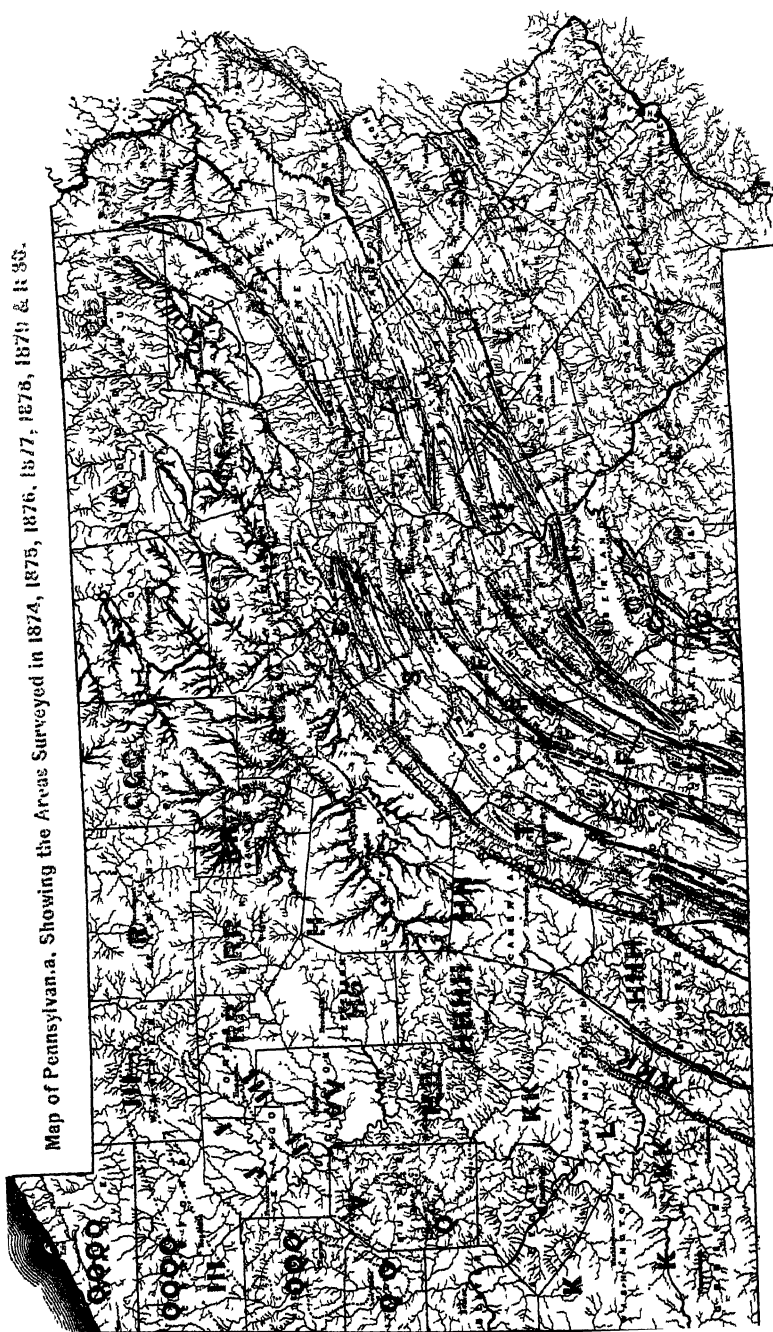


Map of Pennsylvania, a. Showing the Arcae Surveyed in 1874, 1875, 1876, 1877, 1878, 1879 & 1880.



SECOND GEOLOGICAL SURVEY OF PENNSYLVANIA:
REPORT OF PROGRESS
T².

THE GEOLOGY OF
BEDFORD AND FULTON
COUNTIES.

BY

J. J. STEVENSON.

WITH TWO COLORED GEOLOGICAL MAPS.

HARRISBURG:
PUBLISHED BY THE BOARD OF COMMISSIONERS
FOR THE SECOND GEOLOGICAL SURVEY.
1882.

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LETTER OF TRANSMITTAL.

To His Excellency, Governor HENRY M. HOYT, *Chairman of the Board of Commissioners of the Second Geological Survey of Pennsylvania:*

SIR: I have the honor to transmit the following Report of Progress of the Survey in Bedford and Fulton counties, T², by Professor J. J. Stevenson.

It resumes the observations of the minerals and determinations of the structure of that district which he made in 1881, and in the spring of the present year 1882.

It is very full and thorough, consisting of two parts: first, a condensed statement of the order and character of the formations from the Coal-measures down to the magnesian limestones of Siluro-Cambrian age; second, a daybook of observations along all the roads of the two counties, with references to outcrops, mines, and quarries.

I have made an index to the volume, by which a citizen, of Bedford or Fulton county can at once turn to the page on which the local geology of his immediate neighborhood is described.

In this index the formations are sufficiently indicated by name and number (from XIII to II) to enable persons familiar with the local names of streams, ridges, &c. to follow them across the district.

Every mention of a fossil form made by Professor Stevenson will be found in the index, and so arranged as to show at what geological horizon it was found in the Palæozoic column. For this purpose the numbers of the formations are affixed to the names of the fossil forms; and where several formations are included in one number (for

example: Chemung, Portage, Genesee, Hamilton, and Marcellus in No. VIII; Medina and Oneida in No. IV; Hudson River and Utica in No. III; Trenton and Calciferous in No. II) the name of the formation is also given. Further to facilitate this special branch of study I have in all cases arranged the index to each fossil form in a descending order; so that where several species of one genus are mentioned their names stand in the index one below another in the same order in which they occur in the rocks. Palæontologists will find it an easy task to copy out from the index separately the whole list of fossil names, and arrange them afterwards to suit their own purposes.

The numbers from XIII to II adopted by the First Geological Survey of Pennsylvania are a great convenience, and introduce no errors into our revised geology; I have therefore given them at the end of the index, with the names of the formations for which they stand. The only omissions are: that of *Upper Helderberg* and *Corniferous* at the bottom of VIII; that of *Salina* at the top of V; and that of *Chazy* and *Birdseye* in II. These are New York formations not well identified in various districts of Pennsylvania, although no doubt represented by groups of rocks wearing a different aspect. Professor White, in his Report of 1882 on northern Luzerne, Montour, &c. will probably furnish the needed demonstration of the real presence of the *Salina* as a formation of considerable thickness in that part of the State. The *Upper Helderberg* may be represented by the limestones which Professor Stevenson sees reason for assigning to the Hamilton. The *Chazy*, &c. cannot be separated from the great mass of magnesian limestones underlying the *Trenton*. Professor Claypole is occupied with the task of giving a palæontological definition to our formations in Central Pennsylvania.

Colored geological maps of Bedford and Fulton, on a scale of two miles to the inch, accompany this report. They have been reduced from the large private published township maps, used in the field. The contact lines of the formations, limiting the colors, had to be drawn by reference to road crossings and houses as given on the original maps.

It is beyond the means of the Geological Survey to correct the innumerable distortions of private township surveys. These distortions produce errors in the arrangement of the geological colors ; but resident students of the local geology will not find such errors to be of sufficient size to prevent them from using the maps as good guides.

One exception to this statement, however, must be made respecting the indications of *structure* to be found on the geological maps ; and this can be easily explained.

Professor Stevenson felt so strongly the imperfection of the township maps which he used in his field work, that he protested against any attempt at locating the axes of anticlinal rolls upon the geological maps to illustrate his report. Nevertheless I have drawn the anticlinal axes on the maps ; and for a reason. Bedford and Fulton counties belong to the most complicated belt of the State. The long parallel and alternating stripes of color on the maps show this ; and an experienced geologist can see at a glance, by the position and order of the colors, where the anticlinals are and where the synclinals or basins are. But to the common eye the geological map is a maze of confusion, and some mark is needful to assist the eye and to strengthen the judgment. Each grand anticlinal axis throws off the same colors in the same order on its two sides. A grand synclinal axis does the same thing, only reversing the order. By running a broken black line along the axis of the wave and marking it with arrows to show the opposite dips the map becomes easy for any one to consult.

Besides the great folds there are a multitude of smaller rolls in the rocks, some of which are of considerable magnitude, and run for several miles, greatly influencing geological location of minerals and soils. Most of these happen inside of the broad belts of color, and their existence cannot be suspected even by a geologist unless he knows the country. I have, therefore, indicated the principal of these also on the maps, to draw attention to their existence, trusting that the reader will verify their assigned positions by a careful study of the text of the report, and by personal observation at each locality.

I must warn the reader of this report, therefore, that the broken black lines which represent anticlinals on the maps must not be accepted as *geographically accurate*. They have not been located instrumentally, but by reference to some public or private building, bridge, road fork, &c. in the neighborhood, and, therefore, while they are approximately right upon the map, there is always an unknown error due to the imperfections of the private surveys of the townships, and the distortion which has been produced by forcing bad township surveys into worse county maps.

A topographical survey of the State, by order of the Legislature, is a matter of necessity.

The line of the Cove fault, on the Fulton county map, is the best possible illustration of this subject. It has been laid in as accurately as could be done upon the township maps now existing, and yet is evidently not exactly of the shape represented; a fault along two straight lines, making an angle precisely at a turnpike, would be a marvelous occurrence. Nothing but an extensive and costly topographical survey will determine precisely the direction which this interesting break in the crust of the earth takes at every point in the line. There is reason for suspecting that it projects itself across the olive-colored belt, and that it is met at a low angle near the turnpike by a second fault; but this suspicion calls for close scrutiny of the ground.

A topographical survey was commenced. The turnpike was run and leveled from Mercersburg to Bedford as a base line, and marked with painted numbers at every thousand feet; but side lines were not run; and topographical work in other parts of the State caused a postponement of this special survey, which may be taken up and finished hereafter.

The Broad Top Coal field in the north-west corner of the Fulton and north-east corner of the Bedford map is most imperfectly represented, for the same reason as that assigned for other similar deficiencies in the maps. Neither the shape of its borders, nor the spread of the colors representing the Coal measures and the underlying Conglomerate will bear criticism. The scale is too small and the

original township maps too incorrect to allow of more than a mere indication that the Broad Top coal field occupies the two corners of the two counties.

My own survey of the coal field, more than twenty years ago, was very elaborate, and my contoured maps of it covered two thirds of the field. Until the remaining third is surveyed with the same completeness, it would be useless to publish the special geological report on it to which it is as much entitled as any other coal field in the State.

Very respectfully,

J. P. LESLEY.

PHILADELPHIA, *September 2, 1882.*

Professor J. P. LESLEY, *Director of Second Geological Survey of Pennsylvania:*

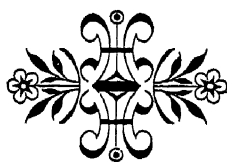
SIR: Herewith I present my report on the geology of Bedford and Fulton counties. Some discrepancies will be noted between the text and the maps, more especially in respect to the Coal measures area of Broad Top. The survey is indebted to you for coloring that area. It is indebted to you, also, for many features of the lines marking courses of the anticlinals.

The work of the Survey was appreciated cordially throughout the district, and material assistance was rendered by many of the citizens. Especial acknowledgments are due to Mr. J. B. Williams, of Everett; Mr. W. Kelly and Mr. John Mitchell, of Riddlesburg; Mr. L. MacDonald, of Huntingdon; Mr. Job Robinson, of Robinsonville, and Hon. G. H. Spang, of Bedford.

Respectfully yours,

J. J. STEVENSON.

UNIVERSITY OF THE CITY OF NEW YORK, *August 22, 1882.*



THE GEOLOGY
OF
BEDFORD AND FULTON COUNTIES.

CHAPTER I.

General Description of the District.

The region described in this volume embraces the counties of Bedford and Fulton, which lie along the Maryland line, with Somerset county at the west adjoining Bedford, and Franklin county at the east adjoining Fulton.

Bedford was set off from Cumberland county in March, 1771, when limits were assigned to it as follows :

“That all and singular, the lands lying and being within the boundaries, following ; that is to say, beginning where the province line crosses the Tuscarora mountain and running along the summit of that mountain to the gap near the head of Path valley ; thence with a north line to the Juniata ; thence with the Juniata to the mouth of Shaver’s creek ; thence north-east to the line of Berks county ; thence along the Berks county line north-westward to the west boundary of the province ; thence southward according to the several courses of the boundary of the province, to the south-west corner of the province, to the place of beginning.”

Originally, then, Bedford county embraced nearly the whole area now included in Fulton, Bedford, Huntingdon,

Blair, Cambria, Somerset, Fayette, Westmoreland, Greene, Washington, Beaver, Allegheny, Indiana, Armstrong, Butler, Lawrence, Mercer, Crawford, Erie, Warren, Venango, Forest, and Clarion counties. Its limits were curtailed first by the formation, in 1773, of Westmoreland county, which took off the area now included in the seventeen counties last named; they were further reduced in 1787 by the formation of Huntingdon county which embraced the present county of that name with much of Blair and Cambria. Somerset county, formed in 1795, took the region lying west from the Allegheny and Little Allegheny mountains; while in 1804 and 1846 other portions on the west and north-west were removed in the formation of Cambria and Blair counties respectively. The last division was in 1850, when the eastern part was set off as Fulton county.

The area of Bedford county is 1003 square miles, or 641,920 acres, and that of Fulton is 442 square miles, or 282,800 acres. The population in 1880 was 34,932 in Bedford, and 10,149 in Fulton.

Bedford county is divided into twenty townships, arranged as follows:

		Bloomfield.	Woodberry.	Liberty.
Union.	King.	South Woodbury.		Broad Top.
West St. Clair.	East St. Clair.			
Napier.	Bedford.	Snake Spring.		Hopewell.
Juniata.	Harrison.	E. Providence.	W. Providence.	
		Colerain.	Monroe.	
Londonderry.	Cumberland Valley.	Southampton.	Mann.	

The eleven townships of Fulton are relatively placed thus:

Wells.	Taylor.	Dublin.
		Todd.
Brush Creek.	Licking Creek.	
	Belfast.	Ayr.
Union.	Bethel.	Thompson.

Drainage.

The drainage of the district belongs to two systems, that of the Potomac and that of the Susquehanna. The area of the former includes only a small part of Bedford county, but the whole of Fulton except Brush Creek, Wells, and much of Taylor and Dublin townships. That of the latter includes in Fulton county only the townships named, but fully four fifths of Bedford county.

The Raystown branch of the Juniata, referred to in succeeding pages merely as the Juniata, is the important waterway of Bedford county, receiving nearly all the drainage within the Susquehanna area. It rises in Somerset county and follows a rudely eastward course across Bedford to the edge of East Providence township, when it turns northward and flows in that direction until it passes into Huntingdon county. The most important tributary is Dunning's creek, which drains the whole north-west corner of Bedford county and enters the river at the west foot of Evitts mountain. Brush creek, entering from the south, drains much of Monroe; East and West Providence, together with the greater part of Brush Creek township of Fulton county. The prominent streams belonging to this area in Fulton county are Sideling Hill, Wooden Bridge, and Little Aughwick creeks, which drain only the northern tier of townships.

The important streams belonging to the Potomac area within Bedford county are Wills, Evitts, Flintstone, Town, Fifteen-Mile, and Sideling Hill, all of which, except the first and last, are comparatively unimportant. Two great streams gather the waters of Fulton county; Tonoloway creek, draining much of Union, Bethel, Belfast, and Thompson; and Licking creek, draining Ayr, Todd, and Licking Creek townships with parts of Dublin, Taylor, Belfast, and Thompson.

The courses of the larger streams are for the most part without relation to the geological structure, while the secondary drainage is clearly connected with the structure.*

[* To discover the reason for the apparently accidental and lawless course of our main streams the geologist must reconstruct the original surface before the first erosion of the uppermost Coal Measures began, and follow the history of the erosion down to the present time.—J. P. L.]

The Juniata, rising in Somerset county, flows eastward across the Savage Mountain, Wills, Evitts, Tussey, Clear Ridge, Grey's Run, Sheaver's Creek, and Snyder's Ridge anticlinals, and after changing its course to northward it recrosses the Snyder's Ridge anticlinal once, the Sheaver's Creek axis twice, the Grey's Run axis thrice, and the Clear Ridge anticlinal thrice. Dunning's creek crosses both divisions of the Savage Mountain anticlinal, the Dunnings Mountain fold and the petty folds of the Bedford synclinal. Brush creek crosses the Broad Top axis once, the Snyder's Ridge thrice, and the Sheaver's Creek once. Yellow creek crosses all the folds of Morrison's Cove, flows through a deep gap in the Evitts-Tussey anticlinal and crosses the Coot-Tussey fold. So in Fulton county, Sideling Hill creek of Wells township rises on the side of Broad Top, and crosses all the folds eastward to and including the Jack's Mountain anticlinal. Tonoloway creek crosses the Whip Cove, Franklin Mills and Pigeon Cove anticlinals; Licking creek, Cove creek, Spring Valley run and Big Spring run cross the Cove fault.

There are, however, variations in some cases where the stream approaches a diminishing anticlinal. Thus the Juniata when it reaches the foot of Wills mountain bends northward and flows around the end of the mountain, though its course is direct through Evitts and Tussey mountains. So Little Aughwick creek, rising in the "Locking" of Cove and Tuscarora mountains, flows northward through Allen's Valley to the end of Cove mountain. Then its course is changed to southward until the end of Shade-Black Log mountain is reached, where the stream again turns to the north, which course is maintained into Huntingdon county.

The Surface.

As the secondary drainage rudely follows the strike of the rocks and evades the softer beds, the surface of the district shows alternating valleys and ridges.

The hard *Medina* sandstone forms Wills, Dunnings, Evitts, Tussey, Black Log, Shade, Cove, Tuscarora and Dickey's

mountains; the *Pocono* Ray's, Sideling and Town hills, Meadow Ground mountain and Scrub ridge or Licking creek mountain. All of these are bold mountains. The sandstones of the *Catskill*, *Chemung*, *Hamilton*, and *Oriskany* form distinct ridges, some of which, especially near the Maryland line, rival in height the mountains of Pocono and Medina.

The frequent occurrence of diminishing anticlinals and widening synclinals in close proximity gives origin to "coves" in both counties. These are enclosed by the mountain ridges which lock at one or both ends of the "cove." This complicated topography renders the region especially difficult for the railroad engineer, as a gap through one of the mountains may lead only into a cove from which no exit is possible, while at best the gaps through the several mountains are arranged geographically so as to be of little service.

No water-gap occurs in Wills mountain or in Dunning's mountain within Bedford county, but the Juniata river and Dunning's creek flow across the low area between those mountains; only one water-gap is found in the Medina ridge of Dunning's-Evitts mountain, and wagon-roads can reach the wind-gaps only by long approaches. Tussey mountain is cut by the Juniata and Yellow creek; but the Raver's Creek gap is incomplete as the stream heads in a cove. Ray's hill is broken by Brush creek and by Sideling Hill creek, the latter near the Maryland line; but good wind-gaps are found in Monroe and East Providence townships of Bedford county. Sideling hill is cut by Tonoloway and Sideling Hill creek, the latter as the line of Huntingdon county, the former near the Maryland line. Complete gaps through the same ridge are made by Wooden Bridge creek and Sindeldicker's run; but those streams rise in the high land between the Bedford pike and the old State Road. Scrub ridge or Licking Creek mountain has no water-gap and its wind gaps hardly deserve the name. Cove and Tuscarora mountains present an unbroken ridge on the east side of McConnell's Cove, while Tuscarora shows a low wind-gap leading from Allen's valley to Path valley.

The minor ridges are more difficult to overcome than the mountains are. Their number is so great and their slopes are so abrupt that the grades of wagon roads are usually tedious and painful.

No good barometric observations were made in Fulton county as the weather was inclement during the whole time of examination. No railroad passes through that county and it was impossible to confirm such barometric measurements as were made. A few satisfactory determinations were made in Bedford county as follows :

Marietta, Union township,	1474
Dunning's mountain, King township,	2040
Pleasantville, West St. Clair township,	1205
Top of Allegheny mountain, St. Clair township,	2609
Bench of Allegheny mountain, St. Clair township,	1995
St. Clairsville, East St. Clair township,	1251
Chestnut Ridge, Napier township,	1907
New Paris, Napier,	1195
Millerton, Napier,	1744
Buena Vista, Juniata,	1298
Summit of Dry Ridge Pike, Juniata,	2126
West End P. O., Juniata,	1831
County line on Dry Ridge Pike, Juniata,	2079
Summit at North end of Snake Spring township,	1744
Rainsburg, Colerain township,	1835
Neal's Gap on Tussey mountain, Monroe township,	1915
Round Knob, Broad Top township,	1990
Summit, head of Six-Mile Run township,	1805

The altitudes of stations on the Baltimore and Ohio railroad, Pittsburgh division, passing through the south-west corner of Bedford county, are given in Report N, thus :

Cook's Mills,	774
Hyndman,	941

The altitudes on the Bedford division of the Pennsylvania railroad (page 18, Report N) are thus stated :

Hyndman,	930
Fossilville,	1091
Buffalo summit,	1856
Mann's choice,	1136
Napier,	1108
Wolfsburg summit,	1118
Bedford,	1062
Lutzville,	1045
Cove creek,	1033
Mount Dallas,	1053

Those on the Huntingdon and Broad Top railroad, on page 17, N, were corrected in 1878 by C. B. Finley, thus :

Mount Dallas,	1053	1054.0
Everett,	1118	1118.7
Bloody Run summit,	1234	
Tatesville,	1096	1094.8
Brallier's summit,	1108	
Piper's run,	947	946.0
Hopewell,	898	898.0
Riddlesburg,	865	864.7
Saxton new depot,	849	859.0
New Bridge,	831	
Fisher's summit,	974	972.2
Cove,	921	918.1
Rough and Ready,	839	888.3
Coffee Run,	872	872.4
Marklesburg,	789	790.4
Grafton,		747.5
McConnellstown,	674	673.7
Huntingdon,	621	621.0

The elevations on the Six-Mile Run branch of this road, are :

Riddlesburg,	865	864.7
Riddlesburg coal mine,	962	
Coaldale or Fairplay,	1126	1131.1
End of Third mile,	1194	
North Point,		1311.0
End of Fourth mile,	1374	
End of track,	1416	

On the Sandy Run branch, the end of the track is at 1025 feet, but M. Finley gives also (Dec. 9, 1878,) the following :

Hopewell,	898.0
R. R. track opposite Chivington Mine,	1297.5

The instrumental levels of about 1200 stations on Broad Top by Prof. J. P. Lesley have never been published, being reserved for a special report on the Broad Top coal region.

Mr. O. Barrett, junior, gives the elevation of Tussey mountain "in road west of Saxton" as 1984 feet.

Additional levels along the Mercersburg and Bedford turnpike and elsewhere will be given in an appendix to this volume, and for others the reader is referred to the instrumental surveys of Mr. Billin and Mr. Ashburner along the northern border of Fulton and Bedford counties published in Report of Progress F, where—

Sideling Hill creek at the Jack's Mountain anticlinal, is	
given at	838'
New Granada,	938.8
Burnt Cabins is according to Col. James Worrall,	870'

General Geological Structure.

The area embraced in this district was examined during the First Geological Survey of Pennsylvania by Prof. John Fraser, Dr. R. M. S. Jackson, W. Alexander McKinley and Dr. A. A. Henderson.

The writer's examinations have led to very few material changes on the map, and these are mostly matters of detail. Had the State directed and authorized publication of a final report immediately after the close of the first survey, when those who did the field-work were at hand to prepare reductions of their field-notes, the changes would have been even fewer than they are. But the report on the first survey was not prepared until years after field-work had been closed and the field-notes were deciphered and reduced by others than those who had made them. The additional information given in this report has been obtained from exposures which did not exist at the time of the first survey. The work is much less difficult than it was forty-four years ago, when roads were comparatively few and mining enterprises were almost unknown.

The column exposed in the district extends from the Upper Coal Measures to the Calciferous, with a vertical thickness of not far from 21,000 feet of rock. The thicknesses of the several groups were determined by pacing, and directions of dip were ascertained by using a pocket-compass. It is certain that the intervals given will be modified when more exact methods of measurement are employed; but such changes will not affect the total materially.

A glance at the map shows that the rocks are much disturbed in this district. The folds are frequently complex; canoe-shaped synclinals and overlapping anticlinals are characteristic features. The folds are described in the next chapter, beginning at the west side of Bedford county.

Most of the greater anticlinals show a sharper dip on the westerly side; but, as will be shown, very many of the axes have the greater dip on the easterly side.

The maps are based on the county maps. That of Fulton county is good, but is defective in the south-east corner; that of Bedford is very defective in the whole of Broad Top and much of Liberty township, and it is equally imperfect in much of Londonderry.

CHAPTER II.

The folds and their relations.

The Savage Mountain anticlinal and synclinal.

The Savage Mountain anticlinal is the same with the Chestnut Ridge anticlinal of the first survey; but the name should be changed to avoid confusion, as Chestnut Ridge of Fayette, Westmoreland and Indiana counties is a bold mountain ridge, whereas the Chestnut Ridge of Bedford county marks only the northern termination of the great anticlinal of Maryland and West Virginia separating the Cumberland coal-field from the main coal area lying further west.

The Savage Mountain anticlinal enters Bedford county from Somerset at the Dry Ridge pike or just south from the Juniata river. There the westerly dip is only 10 degrees while the eastward dip is irregular but increasing eastward, being 15 to 20 degrees near the axis, but becoming 45 degrees at West End post-office, where its direction is S. 70° E.

Exposures under the axis are indefinite along the Juniata and its place cannot be fixed on the stream or on the road at the north. But no rocks earlier than Chemung are brought up until one approaches the Shawnee branch of Juniata just beyond the village of New Buena Vista. There Hamilton rocks are reached. The broad area of Hamilton, stretching eastward here, is due only in part to this anticlinal, as a small anticlinal passes at a little distance east

and crosses the Dry Ridge pike at the line between Juniata and Harrison townships.

From the Shawnee branch of Juniata to the boundary between Napier and St. Clair townships, the anticlinal rapidly increases in strength, and for several miles the crest of Chestnut Ridge which marks its course rivals in height the bold ridges formed by the hard beds of the Chemung series.

But as the fold grows in height the eastern dips become very gentle, owing to the shallowing of the Savage Mountain synclinal and the introduction of new anticlinals; while the westerly dips become abrupt. The conditions are shown by the strips of Hamilton, that on the eastern side being at some points nearly two miles wide, while that on the west side is often less than half a mile.

On the east side of Chestnut Ridge the Hamilton rocks dip at from 10 to 15 degrees and appear to be slightly folded. The Oriskany forms a hogback surrounding the Lower Helderberg nucleus of the ridge. Southward, the Oriskany spreads out in a plate, which curves gently over the southern end of the ridge and reaches barely to the line between Napier and Juniata townships. This rock is ill shown on the east side of the axis where its dip was not ascertained within southern Napier township; but on the west side, where it underruns the Hamilton, its dip is 6 degrees.

The higher rocks of the Chemung form sharp ridges on both sides of the fold. These, united at the south near the Juniata, diverge somewhat rapidly northward until beyond the line between Napier and St. Clair, whence they converge northward almost to the northern line of St. Clair; there the influence of the Pine Ridge anticlinal cuts off the Chemung of the Savage Mountain synclinal, so that it does not enter King township.

The Oriskany shows dips of from 6 to 18 degrees on the east side of the fold, and from 10 to 25 degrees on the west side. Where the anticlinal is strongest and the Lower Helderberg is shown, the Oriskany hogback is distinct; but at the northern end, as at the south, the hogback passes grad-

ually into a plate curving gently over the axis with dips toward all directions northward.

A similar condition, though not so well marked topographically, is shown by the Hamilton, the varying width of whose belt is shown by the valley surrounding the ridge. On the east side, the belt is from one to two miles wide; the rate of dip is flexuous, from 5 to 15 degrees; while at the south where erosion has been energetic, these rocks are exposed for nearly three miles with dips 4 to 8 degrees. The valley is narrow on the west side and the dips vary from 6 degrees at the southern end to nearly 50 degrees near Six-Roads post-office in West St. Clair; but they diminish northward to 18 degrees near Pleasantville and become almost nothing where the Hamilton crosses the axis at George's creek.

On the west side, the lower beds of the Chemung override the anticlinal, so that where the axis is crossed by Bobbs creek, not far below Mowry's mills in Union township, the Hamilton is below the surface. There the fold has become so gentle as to be little more than an interruption of the dip.

The changes in dip shown by the Chemung beds west from the anticlinal are noteworthy. On the Pittsburgh pike, the dip is 30 degrees near the Shawnee branch, but it quickly increases to 45 and then to 65 degrees; which rate is maintained until one begins to ascend the conglomerate ridge, when it suddenly falls to 15 degrees. This continues to the county line in both Chemung and Catskill. In Napier township, where the fold has its greatest strength, the dip at School-house No. 10 is almost 50 degrees, but at a mile further west it is but 35 degrees. Going north-westward from New Paris in this township one finds dips of 35.25 and at last toward the base of the Catskill only 10 degrees. In St. Clair, west from Six-Roads, the dips are 55, 40 and finally 18. But in the northern part of the township the dip at the bottom of the Chemung is 20 degrees, soon becomes 35 and then gradually decreases to 10 degrees, which is approximately the dip of the Catskill and Pocono. Along George's creek, the dip in the Catskill diminishes gradually until it becomes almost imperceptible, but nearer the Alle-

gheny mountain, the rate increases. On Bobbs creek, the dips are 15 degrees, then 30 degrees, but they diminish gradually beyond Marietta.

These conditions suggest that an anticlinal dies out in the north-west edge of Bedford county, entering it from Blair; while at the same time another anticlinal must enter from Somerset to die out before reaching the Pittsburgh pike, while the axis which we have taken for the Savage Mountain fold increases.

The Pine Ridge anticlinal.

A narrow synclinal separates the Savage Mountain anticlinal from the axis of Pine Ridge. The latter anticlinal originates at a little way south from Dunning's creek in East St. Clair township and continues northward through King township into Blair county. It begins where the Savage Mountain axis first diminishes, and its increase is accompanied by decrease in the other. The two anticlinals are not parallel, for Pine Ridge if produced but a short distance would pass into Chestnut Ridge.

The synclinal between the axes is crossed at the first house above the Griffith school on Dunning's creek, where it is abrupt along the axial line. The western side is shown on Bobbs creek near the line of King township, where the dip is S. 30° E. at 15 degrees.

The Pine Ridge anticlinal was recognized south from Dunning's creek between T. Way's house and the Griffith tannery, and it crosses the creek between the Griffith school-house and the mouth of Bobbs creek. Chemung rocks cross it here. The dip on the west side is 15 degrees, while that on the east side is 25 degrees, this being very near the southern end of the fold. The axis passes into King township just north-west from Osterburg, where the road crosses Bobbs creek. There the Oriskany is exposed in a plate dipping gently south-east and south-west. Thence the fold increases rapidly and the Lower Helderberg is brought up. The dips are abrupt on the east side, that of the Lower Helderberg at Hull's quarry being 60 degrees S. 40° E.; but the westerly dips are gentle. The Oriskany shows only 3

or 4 degrees at 3 miles north from the St. Clair line and the Hamilton only 10 degrees.

The course of this anticlinal is marked by a low but distinct ridge known as Pine ridge. Erosion has removed the Oriskany from its eastern side as well as from the Savage Mountain synclinal, which becomes very obscure within a little way north from the St. Clair township line.

The Savage Mountain synclinal.

This is the Buckstown synclinal of the First Survey, but as it holds the Savage or Little Allegheny mountain, the name here given is preferred. Its depth diminishes northward and the trough practically disappears near the northern line of St. Clair township, where it is divided by the Pine Ridge anticlinal.

This basin holds the *Upper Coal Measures* in Maryland; but soon after crossing the south-east corner of Somerset county it so far decreases in depth that only the Pottsville conglomerate remains to represent the coal series. The lower members of the Devonian run out one after another, until in King township the Lower Helderberg occupies the synclinal line. Similarly, the width diminishes in the same direction and the dips become notably gentler.

The axis enters the county at Wills creek. It crosses Wolf Camp run at about midway between Lafferty's and Emerick's mills; it is crossed by the Dry Ridge pike very near the old toll-gate; by the Pittsburgh pike within a few rods of Mrs. Sutter's house; by Dunning's creek near P. Shrimmer's house; and by the line between St. Clair and King townships just east from the Hollidaysburg road. A gentle anticlinal develops along the axial line just south from the Dry Ridge pike and is crossed by that pike at the line between Juniata and Harrison townships. But this disappears before Dunning's creek has been reached, for on that stream it is represented only by a sudden steepening of the eastward dip at a little way above J. Bowser's house.

South from Wills creek, only the eastern side of the basin is in Bedford county. The dips are very abrupt on Glad-

den's run, where the Chemung, Catskill and Pocono are vertical; on Wills creek the dip of the Catskill is 65 degrees, diminishing westward to 55 and 48 degrees; that of the Pocono is from 45 to 20, while the Mauch Chunk varies from 20 to 15 degrees and the dip of the Pottsville at the central line of the trough is barely 10 degrees. A similar diminution of dip appears on Jennings's run, the next north from Wills creek; for the lower beds of the Chemung dip at 65 degrees, while the higher groups show in succession a much gentler dip. Further north, near Fossilville, the lower beds of the Chemung have a dip of 30 degrees, while, on the run entering Little Wills creek at nearly a mile north from Fossilville the highest beds of the Chemung dip at 25 degrees and the Catskill at 20 degrees.

Both sides of the basin are shown on Wolf Camp run, where the dips on the east side vary from 25 to 10 degrees and those on the west side from 20 to 8 degrees. Where Little Wills creek crosses the basin the westerly dips are 25 to 10 degrees, while the easterly dips are from 16 to 8 degrees. The dips are gentle along the Dry Ridge pike on both sides, except for a little way on the west side near West End post-office. On the Pittsburgh pike the dips near the axis are 34 degrees westward and 22 degrees eastward. The former increase rapidly as one goes eastward, but the latter show comparatively little change. In the vicinity of Dunning's creek the east side of the synclinal is short and the dips overturned, while on the westerly side the dip rarely exceeds 16 degrees until above Mr. Bowser's house, where for a little way the rate becomes 35 degrees; but it quickly falls to 10 degrees, which continues until the rocks begin to rise on the Pine Ridge anticlinal.

The basin suddenly becomes shallow after entering King township, owing to the uplifting of the Pine Ridge anticlinal. The Oriskany forms a curved outcrop rising northward into a sharp hill, which encloses a basin filled with Marcellus shales dipping south-south-east and south-south-west. Beyond this northward to the line of Blair county a few insignificant patches of Oriskany sandstone remain, but one can hardly be certain that they are in place.

The Hyndman anticlinal.

Some small folds intervene between the Savage mountain basin and the great anticlinal of Wills and Dunnings mountains, which can be traced more or less continuously from near the Maryland line to the northern edge of East St. Clair township. At the same time, erosion by Little Wills and Buffalo creeks has dugged out broad valleys along the lines of these small anticlinals, so that the exact relation existing among them cannot be made out. For this reason, they may be regarded, for convenience of reference, as forming parts of a fold with double or triple crest, which is here termed the Hyndman anticlinal, as the principal member of the group passes through the borough of that name.

This series of anticlinals begins at the south near the Maryland line and first becomes distinct at a mile north from that line, where the Oriskany comes up and forms a loop-like outcrop around the Lower Helderberg. The synclinal lying immediately east from it here holds the Marcellus shale, but it quickly becomes so shallow that the Oriskany runs out, and northward only Lower Helderberg is shown in it. The anticlinal becomes bolder northward and passes through Hyndman, being crossed by the Baltimore and Ohio railroad where the county road leaves Wills creek. It was seen just north from Wills Creek station on the Bedford railroad, and in the Lower Helderberg ridge for a mile further north. Thence exposures are indefinite and the fold was not fairly recognized again until near the northern edge of Londonderry township, where for more than a mile the eastern side is distinct. A fold occurs in the limestone at Mann's Choice which was followed without any trouble to nearly two miles north from the Pittsburgh pike. A fold, occupying the same place, was found in St. Clair township, but was lost soon after entering King township.

A second fold was seen west from this, which originates at about a mile north from Fossilville in Londonderry township of Bedford county. There it involves the Hamilton rocks. This is evidently continuous, for it is crossed fre-

quently between Bard and Buffalo Springs by the road, and it is cut by the Wheeling pike just west from Mann's Choice. Northward from this pike it was not recognized.

These folds become very close northward, and at many places they show dips of from 50 to 70 degrees. The distance from synclinal to synclinal rarely exceeds 100 rods. It is quite possible that these petty anticlinals are merely irregular wrinkles, but, as already stated, convenience requires that they be grouped.

The Wills-Dunning anticlinal.

This great axis enters Bedford county at the south and its course thence to the Juniata river is indicated by the bold mountain ridge known as Wills mountain. Before reaching the river the mountain breaks down, and thence northward to beyond Dunning's creek the course of the comparatively gentle anticlinal is not marked by a mountain ridge but by a broken, gently rolling area eroded from rocks of the Upper Silurian. Northward from Dunning's creek, the energy of the fold quickly increases, until its course is shown by the abrupt ridge known as Dunning's mountain. It is altogether probable that the axis of Wills mountain is not directly continuous with that of Dunning's mountain, but that the former disappears northward as the other increases, so that the two axes overlap in the space between the two mountains. This, however, is merely conjecture, as exposures are somewhat indistinct.

From the Maryland border almost to the northern edge of Londonderry township of Bedford county Wills mountain is a narrow, compressed ridge forming the boundary between Londonderry and Cumberland Valley townships. Further north the mountain becomes broad and Milligan's cove is eroded along its axial line, dividing the mountain into two monoclinical ridges, viz: Wills mountain at the east, which forms the boundary between Harrison township at the west and Bedford and Cumberland Valley at the east; and Buffalo mountain or ridge, which lies almost wholly in Harrison township. But, where Harrison, Napier, and Bedford townships come together, the energy of the anticlinal

diminishes and the two ridges unite in a bold knob. Thence the mountain loses height and before reaching the river breaks up into two principal prongs. The western prong is the boundary in part between Napier and Bedford and is cut by the river in a low gap near Wolfsburg; the eastern prong lies wholly in Bedford township and barely reaches the Pittsburgh pike. From this line to a mile or so north from Dunning's creek the axis is represented by several small folds, and its axial line lies west from the Bedford and St. Clairsville road until within about a mile of Dunning's creek. South from Brush mountain the axial line lies wholly within Bedford township; but at the point of that mountain, which is the Medina-covered prolongation of Dunning's mountain, it becomes the dividing line between Bedford and St. Clair. Further north the eastern slope of the fold has suffered severely from erosion and only the western slope remains in Dunning's mountain, which here forms the boundary between King township and Morrison's cove.

From the State line north to the southern end of Milligan's cove only Medina rocks are shown; but in the cove the Hudson and Utica slates appear, while directly under the axis two insignificant exposures of the Trenton were found. Northward from the end of Wills mountain to the beginning of Brush mountain Clinton are the lowest rocks exposed, but Medina is shown again in Brush mountain. The axis becomes very bold further north, where Medina forms the western side, but all rocks above the Trenton have been removed from the eastern side to the line of Blair county.

The dips vary, but in a general way they are sharper on the west than on the east slope; while on the west side the dip increases as one goes from the axial line. At Cook's Mills near the Maryland line the Medina dip is westward at nearly 45 degrees, but the Lower Helderberg dips in the same direction at 70 degrees. Opposite Hyndman, the Medina shows a dip of 25 degrees, the Clinton of 26, while the upper beds of the Lower Helderberg are vertical. Where Buffalo mountain originates in the northern part of Lon-

donderry township the dip of the Medina is 80 degrees, the Clinton and Lower Helderberg are vertical, while the Oriskany is overturned. In Milligan's cove, the shales along Buffalo creek near the crest of the axis have a dip of 70 degrees. The Medina in the gap has a similar dip, but beyond the gap the Clinton shales are much distorted, while the Lower Helderberg seems to be vertical at the few exposures found. No good exposures were discovered in the gaps through the Buffalo mountain north from that of Buffalo creek, and satisfactory measurements could not be obtained; but as far as could be determined the same condition exists in them. The great increase in dip on this west side begins with the increasing width and height of the anticlinal, and the abruptness diminishes rapidly north from the end of Milligan's cove.

Detailed measurements of a satisfactory kind were obtained at few localities along the east side of Wills mountain. The dip of the Medina is from 30 to 45 degrees, increasing northward to near the line between Cumberland Valley and Bedford townships; but thence northward it decreases and becomes insignificant at the Pittsburgh pike. The dip of the Clinton is from 22 to 25 degrees in southern Cumberland Valley, but becomes 35 degrees near the Bedford township line, whence it decreases to near the Pittsburgh pike, where the axis breaks down suddenly into a number of petty folds.

The structure in the vicinity of the Pittsburgh pike between Bedford and Wolfsburg is very well shown by the extensive strippings made for Clinton ore. The eastern division of Wills mountain runs out on the pike beyond J. Hafer's house. There it is seen to be a double anticlinal, the dips in the synclinal being 23 degrees eastward and 35 degrees westward. The west side of the eastern anticlinal is midway between the houses of Kennedy and Hafer. The western prong is also double, the eastern axis dying out on the pike near the Juniata bridge, while the western or main division is cut by the Juniata and disappears north from the river at the first house beyond Wolfsburg. Its Medina does not reach the pike.

Beginning with the Medina, as last exposed toward the east on this pike, and going eastward across the numerous ore-strippings, one finds *eleven folds in less than one mile*; but the exposure is incomplete, there being a total concealed space of nearly one third of a mile. The westerly dips observed in these folds are 35, 50, 34, 30, 50, 49, 35, 15 and 45 degrees; the easterly dips are 70, 10, 25, 25, 85, 70, 23, 40, 15, 30 and 65 degrees. In one fold, the easterly dip is 85 degrees and the westerly dip 50 degrees; in another, the dips are equal; in another, 70 east and 49 degrees west; while in another they are 25 degrees eastward and 45 degrees westward. The closer folds are near the ridge, the broader and more complicated further away.

Northward from the Juniata the dips become very gentle on the east side of the Clinton area, barely 15 degrees, but on the west side they are very steep, 85 degrees having been observed in the Lower Helderberg at more than one locality.

The dips of both Clinton and Medina are very gentle at the southern end of Brush mountain where they cross the arch; but they increase rapidly northward, especially on the west side. Near the Weisel place in St. Clair township the Clinton dips 50 degrees, though nearer the mountain its rate is but 36 degrees. The middle ore-bed shows 48 degrees on the Geisler place, but in King township the dip of the Medina is vertical or even overturned to 85 and 80 degrees eastward.

On the easterly side within Morrison's Cove, in South Woodberry and Bloomfield townships, the dips are a little perplexing. Thus on the road leading past Reed's distillery across the mountain the lower Medina has an easterly dip of 80 degrees, while at barely a mile further north the upper beds of the Hudson are dipping westward at 60 degrees. But the overturn is very marked in Bloomfield township, for the lower Medina near J. Long's house dips eastward at 23 degrees, and near E. Holsinger's house the Calcareous is dipping eastward at 28 degrees.

An interesting feature is the intimate relationship apparently existing between this and the Savage Mountain anticlinal. The great widening of the Wills Mountain anticli-

nal is directly opposite the marked shallowing of the synclinal and the flattening of the Savage Mountain anticlinal ; while the almost total disappearance, topographically, of the Wills-Dunning axis is directly opposite the swelling of the Savage Mountain anticlinal in Chestnut ridge. In like manner, as the great anticlinal again developes itself north from Dunning's creek the Savage Mountain anticlinal dwindles away.

The Bedford synclinal.

This is well marked in Bedford and Cumberland Valley townships, where it has Wills mountain on the east and Evitts mountain on the west to define it ; but the general uplifting of the whole region northward and the development in the same direction of the small anticlinals within the basin bring up the Lower Silurian limestones north from Bedford township, which have yielded to erosion and have formed Morrison's cove. This reaches from Dunning's to Tussey mountain and embraces both this synclinal and the Evitts-Tussey anticlinal ; so that in Morrison's cove, no striking topographical feature remains to define the synclinal.

The synclinal is narrow at the Maryland line, the distance from the crest of Wills to Evitts mountain being only 4 miles. It widens to $4\frac{1}{2}$ miles at Centerville, but soon contracts so that before the line of Bedford township has been reached its width is but 2 miles. Thence northward it widens, owing to the eastward bending of Evitts mountain, and the widening is rapid north from the Juniata river. Toward the northern edge of Bedford township it again contracts, and thence to the Blair county line the open space of Morrison's cove varies from 5 to 7 miles owing to the disappearance of the Evitts-Tussey anticlinal.

The central portion of this trough in Cumberland Valley and Southern Bedford is marked by a double ridge known as Knobbly mountain, which is ordinarily most pronounced on the western side of the basin. This is composed of Oriskany and Lower Helderberg, while between the two divisions is an irregular valley of Hamilton. The two ridges unite near Bedford Springs, and thence to the river the re-

sulting ridge is known as Holmes ridge. Nothing newer than Marcellus was recognized here.

The Clinton forms a continuous outcrop north from the Juniata, from the river along the foot of the mountain to the river again. A similarly continuous outcrop of Lower Helderberg lies within the Clinton, while Oriskany, Hamilton, and Chemung occupy the oval space within. The increasing strength of the uplifts has caused a shallowing of the basin, so as to carry the Medina out northward at the edge of Bedford township; thereby exposing within Morrison's cove, as has been stated, only the Lower Silurian beds.

The Bedford synclinal is not simple, but has on each side of its center line a small anticlinal. That on the west side is easily followed from the State line north almost to the edge of Morrison's cove, and an anticlinal following very closely the same line was traced through South Woodberry into Bloomfield township in the cove. That on the east side cannot be traced so readily as all exposures cease midway in Cumberland Valley township and nothing can be seen thence until one passes Bedford Springs. There an anticlinal is shown which seems to be the same with a fold seen north from the river, which in its turn is clearly the same with that which makes a deep notch in the Medina outcrop and is easily traceable thence to beyond Woodberry in Woodberry township.

Near the State line, the dip of the Lower Helderberg and Clinton on the Cumberland road is 25 degrees; half a mile further east, in Knobbly mountain, it is 15 degrees; but on the east side of the ridge the dip increases abruptly to 55 degrees in the Oriskany. Crossing the synclinal a sharp westward dip is seen in the Hamilton and soon the Oriskany is seen describing an anticlinal; beyond this fold the dip is westward at 40 degrees.

The eastern anticlinal is easily followed from the State line northward and where last seen in Cumberland Valley township has a westerly dip of 30 degrees while the easterly dip is from 80 to 85 degrees.

The western anticlinal is crossed by the Cumberland road many times in Cumberland Valley township, but is narrow

and shows dips of 20 to 30 degrees. The rate increases northward, for, in Bedford township, this anticlinal has a westerly dip of 60 degrees and an easterly dip of 50 degrees near the township line. The latter quickly diminishes to 30 degrees as it approaches the synclinal. Further north on this Cumberland road, the easterly dip near the axis of the fold is 20 degrees, but it becomes 27 degrees at 60 rods further east. A sharp and somewhat complicated fold occurs on the Pittsburgh pike immediately east from the fair-ground, which possibly represents this axis. The synclinal passes through Bedford borough and is crossed by the river at the iron bridge; while the eastern anticlinal is shown on the road from the springs, where it enters the borough.

The western axis is shown north from the river on the St. Clairsville road and it is very sharp though narrow at the fork near A. Samuel's residence. The eastern anticlinal cannot be traced northward from the river for three miles; but at that distance a well-marked fold is found with dips of 25 degrees. This increases in strength northward and brings up the Medina in a projecting point which forms what is known as Dibert's corner.

Crossing the ridge of Medina, which forms the northern limit of Bedford township, one comes into Morrison's cove. Here the eastern or Woodberry anticlinal is much stronger than in Bedford township. It is crossed by Beaver creek near the road leading south from New Enterprise; passes just east from New Enterprise and through Jacob Furry's property; is crossed by the pike near the northern edge of Woodberry borough and again at J. Replogle's, at nearly two miles north from the borough. The dips near Beaver creek are 30 degrees east and 25 degrees westward; north from New Enterprise the westerly dip near Haderman's tannery is 50 degrees, but the easterly dip on J. Furry's property could not be made out. The westerly dip near the River Brethren church south from Woodberry is 60 degrees, and the easterly dip is not far from 15 degrees, as shown at the mill on Yellow creek near Woodberry. The dips are not well enough shown at Replogle's to admit of measurement.

A new anticlinal appears in the cove, following the line of the synclinal axis, but owing to the peculiar erosion of that area it is rarely shown. It lies about one mile westward from the Woodberry anticlinal, passes at this distance west from New Enterprise and is crossed by the west branch of Yellow creek very near the township line between Bloomfield and Woodberry. It was not traced further north as the deep cover of *débris* on The Barrens conceals everything.

The anticlinal following the west side of the trough cannot be traced in Morrison's cove, owing to the sand ridges known as The Barrens. A fold was seen on John Stayer's property, two and two thirds miles west from New Enterprise. An anticlinal was crossed on the pike immediately beyond the northern limit of the county. The dips at Stayer's are equal, but those at the northern locality were not determined.

The Evitts-Tussey anticlinal.

The anticlinals of Tussey and Evitts mountains may be considered as a single anticlinal with a synclinal depression along its crest.

The two anticlinals are distinct in Bean's cove of Southampton township, but the synclinal between them rapidly becomes shallow northward. It is sufficiently distinct in Colerain and Snake Spring townships to a little way north from the Juniata river, but thence northward it could not be recognized and the two anticlinals are clearly united before the northern edge of Snake Spring township has been reached. A slight saddle may still exist there but it is certainly insignificant. The dwindling of the crest synclinal is shown on the map by the convergence of the Medina outcrops.

The united axis soon disappears northward. The westerly dip was seen just north from the border of Snake Spring township, and again near where the road reaches Beaver creek; but thence northward, no westerly dip was seen, and the axis is evidently overridden by the Woodberry anticlinal. At best the western slope becomes north-

ing more than a mere interruption of the dip. In like manner the eastern slope practically disappears. (The axis of which Tussey mountain is the eastern slope in Liberty and much of Hopewell townships of Bedford county is a different anticlinal from that under consideration.)

The Evitts anticlinal is easily followed by means of Evitts mountain, which enters Bedford county from Maryland and continues northward to the southern border of Woodberry township. Its course is north-north-east to the Juniata, where it bends almost to north-east as the Bean's Cove synclinal narrows. The ridge is an anticlinal in its southern portion, with the white or upper Medina forming its crest and slopes, and showing dips of 40 degrees westward and 32 degrees eastward. The fold becomes bolder toward the head of Bean's Cove; the lower Medina is thrust through the upper, and soon the ridge becomes a monoclinical, the Medina having been eroded wholly from the eastern slope. The dip on the western side, as shown at the crest of the ridge on the Rainsburg and Centreville road, is from 70 to 80 degrees westward. The axial line could not be followed in Colerain township, as much of the area is covered deeply with debris.

The many deep cuts along the Chambersburg and Bedford pike afford good exposures of the Evitts fold. The dip of the upper Medina is eastward at 85 to 90 degrees, while the lower Medina is thrown into folds with dips of from 45 to 85 degrees eastward. The crest of the main fold is reached at the church and school-house beyond Willow Grove hotel, where the dip on the west side is 70 degrees and that on the east side is 40 degrees in the same direction. Further northward, exposures are very indefinite; vertical dips occur in the Clinton rocks on the west side at two miles north from the Juniata; while on the summit, at the northern end of Snake Spring township, the Hudson beds near the crest of the united axis are dipping W. N. W. 30 degrees. A westward dip of 20 degrees was seen where the road crossing this summit reaches Beaver creek; but thence northward, as already stated, the western slope of the fold cannot be traced.

The Bean's Cove synclinal is distinct in Bean's Cove of Bedford county ; in Colerain and Snake Spring to a short distance north from the Juniata river. The axis is marked by Martin ridge in the cove, and by a projection known as Martin hill in southern Colerain. The Middle ridge of Colerain and Snake Spring lies very near it. The axial line passes near D. L. Rice's house in Martin ridge ; very close to the forks of Flintstone creek in the northern part of Bean's Cove. It is crossed by the Rainsburg and Centreville road in Colerain at the line between school districts 1 and 2, and by the Chambersburg pike on J. G. Hartley's property very near the Luthern church. Beyond the pike it could not be traced.

The shallowing of the synclinal northward is very marked. At the State line the Oriskany is shown on Martin ridge, while the Lower Helderberg and the Clinton occur on each side. Toward the northern border of Bean's Cove the curved outcrop of each of these groups is shown crossing from Evitts to Tussey, while the bold northern outcrop of the upper Medina forms Martin hill, said to be the highest point in Bedford county. Thence northward only Trenton and Calcareous rocks occur in the trough until it disappears and Hudson rocks cross the united but weakening folds on the high ridge which joins the Medina outcrops at the northern edge of Snake Spring township.

Few exposures within Bean's Cove exhibit the dips clearly. A gentle anticlinal follows the eastern side of the basin from the State line to within three miles of the Colerain line. The dip is steep at the immediate crest where the fold is somewhat complex, but away from that the dips are from 3 to 15 degrees. The dips appear to be comparatively gentle at the northern end of the cove. The dip is but 18 degrees on the west side of the synclinal where Cove creek is crossed in Colerain township by the Rainsburg and Centreville road ; and it is 20 degrees S. 55° E. at a locality somewhat further down the stream. But where the road crosses the axis the dips are sharper. A cutting exposes the synclinal on the Chambersburg pike, but there the trough has become a

mere wrinkle and the eastward dip is regained within a few yards.

The Tussey anticlinal is marked by Tussey mountain from the Maryland line northward to the head of Snake Spring township; there Tussey mountain proper ends, the continuation of that ridge being another mountain and formed by another anticlinal. Like Evitts, Tussey is a distinct anticlinal from the State line to the northern limit of Bean's cove, but thence the ridge is monoclinical to the head of Snake Spring township. White Medina forms its crest, and the dips on the road leading from Bean's cove to Chaneysville are 40 degrees westward and 25 to 30 eastward. At Neils gap the white Medina has an eastward dip of 27 degrees, but the lower rocks are very poorly shown. Erosion by Cove creek conceals everything along the foot of Tussey mountain in much of Colerain; but a dip of 27 to 33 degrees S. 40° E. was seen very near the northern border of that township.

Very fair exposures occur along the Chambersburg pike and in the Juniata gap through this mountain. In the mountain the Upper Medina shows dips of 50 to 75 degrees eastward, the rate increasing westward; the Lower Medina has dips of 35 to 80 degrees eastward, the rate increasing from 48 to 80 and then decreasing to 35; thence for several hundreds of feet the rate varies from 30 to 60 degrees, but finally becomes 40 to 43 degrees, which rate continues to the crest of the axis. Whether or not subordinate folds occur in the Lower Medina cannot be determined satisfactorily, but one small wrinkle seems to be indicated.

Everything indicates a violent crush at the mouth of the Juniata gap through Tussey mountain. Exposures of the Clinton are indefinite, but such as do occur show that the group is represented by barely 400 feet of rock, which is thrown into serious distortions. The gap itself shows such irregularity as to suggest a cross-fault.

Northward from the Juniata gap, no determination of dip could be made until the Yellow creek gap was reached in Hopewell township. There the dips are from 30 to 35 degrees, the latter rate being in the Lower Medina. The struc-

ture is simple there, no evidence of subordinate anticlinals having been observed.

The last measurements made were on the road leading from Woodberry to Raver's gap, where, beyond the road leading to Henrietta, the Lower Medina dips eastward at 33 degrees, while at a little way further west the upper beds of the Hudson show a dip of 27 degrees. Thence the dip is eastward until the Woodberry fold has been crossed. Thus all traces of the Evitts-Tussey anticlinal have been lost.

The Tussey anticlinal is less abrupt than the Evitts. No vertical dips were observed in the former, whereas the latter is overturned in the Juniata gap.

The synclinal between Evitts-Tussey and Coot-Tussey axes is obscure in West Providence township, but it becomes distinct near the line of Hopewell, and thence to where it runs out it can be traced distinctly. It is occupied by Clinton rocks in Hopewell, and these are thrown into many petty folds. The exposures are too imperfect to admit of one's determining the number of these flexures.

The Coot-Tussey anticlinal.

This fold first shows itself near the northern edge of West Providence township as a gentle fold in the tunnel of the Kemble Coal and Iron Company's mine, where it is crossed by the Lower Helderberg. It grows northward, so that before Piper's run has been reached the surface rocks are Clinton, the highest beds of that group outcropping on each side of the axis. Thence to Yellow creek the course of the fold is marked by an irregular ridge produced by the hard upper rocks of the Clinton and known as Black Oak ridge. North from Yellow creek the fold quickly develops, and within a short distance the Medina is brought up so as to form the bold Coot mountain on which the Medina outcrop forms an angle with its apex pointing southward. From Coot mountain the ridge is known again as Tussey mountain and extends into Huntingdon county. The outcrop of Medina on the easterly side is unbroken save by gaps through which streams flow.

The axis of the anticlinal is crossed by the Kemble company's tunnel in the northern part of West Providence township ; by Piper's run just south from J. E. Ritchey's house ; by Yellow creek in the village of the same name ; by Raver's creek road at about 60 rods north-west from S. Stonerook's house ; while in Leathercracker cove, near the Blair county line, its place is indefinite owing to the presence of two faults.

The dips in the tunnel of the Kemble company were not obtained accurately ; the easterly dip is nearly 50 degrees, while that on the westside is somewhat greater. The dip of the Lower Helderberg limestone at Piper's quarry on Piper's run is 10 degrees N. 50 degrees W., but thence to the crest of the fold at Ritchey's house the rocks rise as it were by leaps. No good exposure to show dips was found on the easterly side of the fold here until Whitehall's quarry in the Lower Helderberg was reached, where the limestone dips E. S. E., at 35 degrees. The structure is very irregular on Yellow creek, very like that seen at the northern end of Wills mountain. Three distinct folds are shown in the Clinton as that group crosses the anticlinal, and these are well exposed in the road leading from Yellow creek gap to Hopewell. The easterly dips are 70, 40, and 60 and 30, while the westerly dips vary from 15 to 33 degrees.

The dip of the Medina was not ascertained between Yellow creek and Raver's creek ; but the easterly dip of the Clinton is 50 degrees, and that of the Lower Helderberg is 60, while in the gap of Raver's creek the Medina dip is but 47 degrees. The westerly dip on the opposite side of the anticlinal in this gap could not be determined as the exposures are too imperfect to admit of measurement. Further north, the Lower Helderberg has a dip of 40 degrees N. 70° E. at the Kemble Coal and Iron Company's lime quarry near Cove station ; while on the west side of the mountain near the county line, the lower Medina dips eastward 60°.

The faults in Leathercracker cove or the valley of Clover creek in Woodberry township are two. The eastern one is ill shown within Bedford county. It brings the Utica shale into contact with the lower Medina. Probably the fault is

insignificant in Bedford county, so that it is little more than a sudden change of the dip from 30 to 60 degrees. The western fault lies on the opposite side of the valley. There the Hudson shales are on the west side while the Trenton limestone is on the east side of the fault. Like the other, this fault is greater in Blair than in Bedford county. The dip in the Hudson is 32 degrees, in the Trenton from 28 to 30 degrees, the direction being eastward in both.

Structure east of Tussey mountain.

The region lying east from the Tussey anticlinals is complicated in its structure. The rocks belong, except in Warrior ridge and in the northeastern corner of Bedford county, to the Devonian, and consist of shales and sandstones most of which yield readily to the weather. Away from the Juniata river the drainage is for the most part north and south, so that in seeking to work out the structure one must depend on such accidental exposures as have been made during construction of country roads or by the washing during severe storms. The exact relations of anticlinals and synclinals detected along the numerous east and west cross lines of traverse between Tussey and the east county line can be determined only with difficulty. Especially is this the case with the complicated Snyder ridge folds.

The Clear Ridge anticlinals and synclinals.

A very distinct anticlinal, which may be termed the Chaneyville anticlinal, was seen in Southampton township of Bedford county. It is crossed by Town creek nearly opposite to McLewee's gap in Warrior ridge, or 5 miles south from Chaneyville, where the dip on the eastern side is E. S. E. at 45 to 50 degrees. The same axis passes through the village of Chaneyville, where however the exposures are too imperfect to show the rate of dip accurately. Northward, the erosion by Elk creek and Clear creek prevents any tracing of the fold. If it be continuous it may be represented by some short and comparatively insignificant folds near Everett. But the interval is too great to

permit identification. The axis of the synclinal between this and Tussey mountain was seen only in Chaneyville, where the dip on the west side is nearly 40 degrees, as shown at the hotel in that village.

A synclinal follows Clear ridge in West Providence township, which was first seen at about two miles north from the Monroe township line, where the road turns eastward from the ridge road. It is shown somewhat indifferently on the same ridge east from the Sparks school-house; its place is concealed on the Bedford and Chambersburg pike, but it is exposed on the Juniata river at nearly one mile below the mouth of French's run. At its origin, it holds only the Chemung, but, deepening northward, it at last holds the high point of Pocono known as French's knob, the western termination of Harbor or Terrace mountain.

The Clear Ridge anticlinal was first recognized at nearly two miles north from the Monroe line, where it is well shown at say 50 rods from the ridge road as one descends to the Clark school-house on Grey's run. It is represented by an abrupt compression of the beds on the ridge near P. W. Sparks' house; it is crossed by the Chambersburg pike near I. Ritchey's house, where the dip on the easterly side varies from 70 to 90 degrees. Thus far it has been crossed by no rocks higher than the Chemung; but northward from the pike it becomes depressed, so that where crossed by the Juniata river it carries the whole of the Catskill. It is well shown in the river bluff opposite W. Osborn's house, with dips of 50 degrees westward and 35 degrees eastward. It may be represented by the insignificant double anticlinal seen along the Juniata in Broad Top township; but an identification would necessarily be very indefinite.

The Clearville synclinal.

The Clearville synclinal is the most noteworthy in this part of the district, being the deepest and most distinctly marked. It lies between the Chaneyville and Clear Ridge anticlinals at the west and the Sheaver Creek anticlinal at the east.

The western limit in Southampton township is the Cha-

neyville anticlinal, the exposures on the road leading west from McLewee's gap through Warrior ridge being sufficient to indicate that the Clear Ridge anticlinal does not extend so far south. The course of this synclinal is shown in Southampton township by two bold ridges, known as Polish and Ragged mountains, whose crests are formed by the Chemung upper conglomerate. The synclinal becomes shallower southward, so that at or just beyond the Maryland line, the conglomerate runs out and the two ridges are united. Deepening northward, this synclinal soon holds the Catskill, and at the southern boundary of Broad Top township it holds the Pocono.

In Southampton the axis passes very near the cross-roads at two miles north from the State line; it is crossed by Wilson's run about midway between school-house No. 5 and H. Ruby's house, or not far from 2 miles above Chaneyville by the run. The dips vary from 20 to 35 degrees. The Catskill and Chemung conglomerates of the east side make up Ward's ridge, while the conglomerate and the higher Chemung beds make the summit of Clear ridge on the west side.

The place of the axis was not determined closely in southern Monroe, but the line passes not far from the Lutheran church in School District No. 8, there being a distinct westward dip at Jacob Fletcher's, half a mile east of the church, while imperfect exposures almost immediately west from the church show an easterly dip. Exposures on the side of Clear ridge give a dip of 55 to 60 degrees eastward. Further north in this township the axis passes through the village of Clearville, opposing dips being shown in exposures on the east and west sides of the village. The Chemung upper conglomerate of the east side of the basin forms Black Oak ridge.

The trough is divided in West Providence township by an anticlinal which first appears near the southern edge of the township. The axis of the western sub-syncline is crossed midway between Grey's run and Miss Calhoun's house on the road from the Clark school-house to the summit of Clear ridge; while the axis of the eastern sub-syncline passes

at a little way east from H. O'Neal's house on the road leading south-east from the school-house. The Grey's Run anticlinal is shown on the same road about midway between the school-house and O'Neal's house. Further north, on the road leading from Sparks school-house to Mench's store, the western axis is crossed at nearly 70 rods west from Grey's run, while the eastern axis is crossed very near J. Zembower's house or about 200 rods east from the run. The anticlinal is shown at very nearly midway between the run and Zembower's house. On the Chambersburg pike, the western axis passes very near the first fork west from A. Morgart's residence, while the eastern is shown at the old toll-gate. In the former, the westerly dip is 30 degrees, while in the latter it is but 20 degrees. The Grey's Run anticlinal is very gentle on the pike, where it is well shown in a side cutting west from the old toll-gate.

The western division of the Clearville synclinal is crossed by the Juniata river immediately below the mouth of French's run, while the eastern division is crossed by that run within half a mile from the river. The Grey's run anticlinal is shown at the mouth of French's run, where it is a bold though narrow fold with sharp dips on each side. It makes a deep notch in the Pocono outcrop on Terrace or Harbor mountain, (the narrow, abrupt ridge forming the northern boundary of East Providence township.) This anticlinal is sufficiently well shown on the north side of that mountain, where it carries a point of Pocono northward to Sherman's run and makes a notch in the Pottsville outcrop on the north side of the valley. It crosses Sherman's run in Broad Top township at the bend of the stream about 60 rods above J. Rinard's saw and grist-mill; while the eastern division of the Clearville synclinal is reached between that and the Rinard school-house.

The width of the Clearville synclinal diminishes northward; it is nearly 4 miles in Southampton, but at the southern edge of West Providence it is little more than 2 miles. The width is somewhat less than 2 miles from the Juniata northward.

The Sheaver's Creek anticlinal.

This prominent anticlinal can be followed without difficulty from the Maryland line northward to Sherman valley in Broad Top township.

The exact line followed by the axis could not be ascertained near the State line, owing to poverty of exposures, but its eastern slope is distinct at half a mile west from 15-mile creek, and the axis passes at not more than a mile west from the creek at the Bennet school-house. The exposure there, though sufficing to show the easterly dip, does not give the rate. The axis is crossed by Wilson's run at little more than a mile south from the line of Monroe township, very near where that run is crossed by the road leading from Chaneyville to Piney creek. Here the eastern side is ill-shown, but the western side is exposed in the run near the crossing. The westward dip is about 35 degrees.

In Monroe township the axis is crossed by Chapman's run, the east fork of Sheaver's creek, near H. Mills' house, little more than 2 miles north from the Southampton line. Here, however, the exposure is indefinite and the place of the axis could not be determined within 200 yards. Further north in this township the axis is crossed by the Clearville road between the houses of J. Weimer and W. Amick, at somewhat more than two miles from Clearville.

Owing to extensive erosion the place of this axis could not be determined closely in West Providence township near the Monroe line, but it passes near A. Mellott's house, two miles and a half W. N. W. from the south-east corner of the township. The same difficulty occurs further north near Mench's store, but the place of the axis can be fixed approximately at a few rods west from G. Mench's house. Thus far the arch is crossed by no rocks newer than Chemung, and the outcrops of the Chemung upper conglomerate on each side are at nearly the same distance apart from the State line into southern West Providence; but northward from Mench's store it quickly becomes depressed, so that at the Juniata river it brings up no Chemung rocks but is covered by Catskill.

It is crossed by the Juniata at the bend in the stream above Brush creek, and its slopes are well exposed in the cañon-like gorge by which the Juniata breaks through this and succeeding axes toward the east. The many deep cuts along the Chambersburg pike exhibit the structure. The westerly dips are irregular; at the old toll-gate the rate is barely 20 degrees; soon it becomes 70 degrees; then diminishes to 15 but becomes 20 again as the crest of the fold is approached. The eastward dip is 85 degrees. The axis is crossed at half a mile south from French's run, nearly one mile east from the line of West Providence. It is clearly shown on French's run and it is crossed by Sherman's run in Broad Top township at say 75 rods above the Rinard school-house, where it brings the Pocono down to the road.

The Snyder's Ridge synclinal.

This is very well shown near the State line within a few yards of 15-mile creek, where the dips are comparatively gentle. Erosion has cut deeply here and Chemung shales are shown. Northward, near the line of Monroe township, it passes close to G. Coonrod's on Snyder's ridge, where the Chemung upper conglomerate is caught on the ridge. This synclinal follows the crest of Snyder's ridge in Monroe township and passes very near D. Mills' house. It is crossed further north by Sheaver's creek very near Logue's mill, about two miles and a half east from Clearville. The conglomerate of its eastern side makes Raccoon ridge, cropping out along the crest of that ridge.

Exposures are very indefinite in West Providence township south from the river, and the axis could not be detected; it is clearly divided by an anticlinal before reaching the Juniata. On the Chambersburg pike the exposures are good. The western division is crossed at the river-bend below the mouth of Brush creek. The anticlinal dividing the trough is narrow, the westerly dip continuing for but 120 yards, when it is abruptly reversed, and the other division of the synclinal is reached very near the line between East and West Providence townships. The easterly dip on the anticlinal is sharper than the westerly. Further north

the exposures are indefinite ; whether or not the anticlinal is persistent could not be determined. A synclinal was crossed by the road south from French's run at less than half a mile west from the Reformed church and the same synclinal was seen on French's run below the forks of the stream. But here the country is largely covered by dense forest, and in the absence of an accurate map there is little possibility of making accurate determinations. An anticlinal is present on Sherman's run in Broad Top township, one mile above the Rinard school-house, and a well-marked synclinal was seen both above and below it. These doubtless represent the Snyder's Ridge synclinal.

The Snyder's Ridge anticlinal.

This complex anticlinal can be followed without difficulty from the State line northward to French's run in East Providence, and its place is sufficiently distinct on Sherman's run in Broad Top, though details respecting it cannot be gathered in West Providence south of the river and in Sherman's valley owing to poverty of exposures. The extreme distance from the Snyder's Ridge synclinal to the Felten synclinal is somewhat more than two miles, but in this interval are the several distinct folds which have been grouped together under the name of the Snyder's Ridge anticlinal.

This group is crossed by the road leading from the Bennett school-house on Fifteen-mile creek to Lashley's store on a branch of Piney creek. Four folds were recognized in this interval, but the exposures are far from being complete, and other folds may be present. The dips are from 25 to 35 degrees, usually somewhat stronger on the east than on the west sides of the anticlinals. The very high knob known as Huff's knob, near the State line, holds this group of anticlinals. It is a relic of Chemung conglomerate caught in the synclinals along the crest of the fold.

Further north, near the Monroe township line, five folds were recognized in ascending the east side of Snyder's ridge from the forks of Piney creek at Mrs. Leasure's house. Exposures are very bad in southern Monroe, and only one

of the folds was seen. This passes near G. Croghan's house at barely 50 rods west from Piney creek. The dip on the eastern side is 55 degrees, but that on the other side is imperfectly shown. Two folds were seen on the road leading across Raccoon ridge from Logue's mill on Sheaver's creek, but no details could be gathered. No traces of the folds were found in West Providence south from Brush creek as everything is wholly concealed. The eastern folds are shown on the horse-shoe bend of Brush creek within East Providence. One of the synclinals crosses the horse-shoe at the mill-tunnel, where the dips are 60 degrees N. 50° W. and 40 degrees S. 50° E. The most eastern fold belonging to this group is between this point and Felton's mill.

Southward from West Providence township no rocks newer than Chemung cross the arch of this anticlinal; usually only the lower beds are shown and the higher beds are caught only on Huff's knob. But the arch is lowered in West Providence, so that before Brush creek has been reached it is covered by Catskill.

The group of folds is shown well on the Chambersburg pike as it follows the Juniata river. Five petty folds were seen here between the West Providence line and the Juniata crossings, all of which, except the easternmost, undoubtedly belong to the Snyder's ridge group of folds. All of these show a gentle dip on the west side and a much sharper dip on the east side.

The Snyder's Ridge anticlinal passes east from the Reformed church in the north-west portion of East Providence, and its place is indicated on Sherman's run in Broad Top township by points of Pocono between the houses of C. Lane and Mrs. Worsing.

The Felten synclinal.

This, lying between the Snyder's Ridge and the Broad Top anticlinals, was traced with some difficulty in the southern part of the county. Exposures in the Chemung shales there are somewhat indefinite and the proximity of the complex Snyder's Ridge anticlinal renders one liable to confusion.

The synclinal was identified on a branch of Piney creek within half a mile of Lashley's store, but the exposure is too indistinct for determination of the dips. No exposures occur northward on the Piney creek road. The course of the synclinal is marked however by an irregular ridge due to the Chemung conglomerate. Northward, the trough deepens, so that in southern Monroe, its course is marked not by a single ridge but by two, Raccoon and Hoop-Pole, containing the outcrops of the conglomerate. Further north, the axis is shown on the west side of Hoop-Pole ridge at a sharp eastward bend of the road nearly two thirds of a mile north-east from the Nycum school-house. It passes into West Providence at a few rods from the south-east corner of the township, where its eastern side shows a dip of 40 degrees. It passes quickly into East Providence, where it is crossed by a branch of Sheaver's creek at one mile below Strait's mill. There the westerly dip is 60 degrees, while the easterly dip is barely 25 degrees.

The rapid deepening of the synclinal is shown by the presence of Catskill at Strait's mills and thence northward. Whether Catskill be present or not in Monroe township could not be determined satisfactorily; but judging from the topography the group probably extends into that township.

The trough is divided in the southern part of East Providence by a gentle anticlinal, which crosses Brush creek at Felten's mill and is very narrow, though showing dips there of 40 degrees on each side. The same little fold is shown on the Juniata, where the eastern division of the trough is crossed at about 100 rods above the Juniata crossings. North from the Chambersburg pike the trough was recognized in the ridge west from the Lutheran cemetery, where traces of Pocono sandstone still remain. The presence of this trough is shown on Sherman's run by a recess in the Pocono outcrop near the cross-roads, a mile and a half west from the Fulton county line.

The Broad Top anticlinal.

This is the strongest of the anticlinals in Bedford county

lying east from Tussey mountain. Its eastern side is marked by Addison ridge from the Maryland line to Brush creek, that ridge carrying the outcrop of the Chemung upper conglomerate; while north from Brush creek a well-defined ridge of Catskill continues to the northern edge of East Providence. This axis notches Terrace or Harbor mountain; makes a broad fold of Pocono at the head of Sherman's valley; makes a deep notch in the Pottsville outcrop on the north side of that valley; and is persistent as the ridge in which head Sandy and Six-Mile runs on the west and Trough creek at the east. It is by far the best defined of these anticlinals.

It is distinctly double near the State line, the western axis being short and separated from the eastern or main fold by a narrow, sharp synclinal. The eastern fold is reached where the road crosses a branch of Piney creek and turns to ascend Addison ridge on the way to Leasure's, or Sideling Creek gap, through Town hill. This fold should pass very near the mouth of Piney creek; but there, as well as for a long distance northward, the broad valley of Sideling creek conceals everything. Addison ridge forms the east side of the fold, Hoop-Pole ridge the western, while the west fork of Sideling creek flows in the valley between them. The dips are very distinct in both ridges and the upper conglomerate of the Chemung is shown at their crests. The exact place of the axis cannot be fixed in southern Monroe; but northward, within two miles of the East Providence line, it is shown between the houses of A. Messersmith and T. Mellott at a few rods west from the west branch of Sideling creek. The dip on the west side near Messersmith's is from 70 to 90 degrees, but the dip on the east slope is but 35 degrees. The fold is double here, also, but the details of the minor fold could not be ascertained. Thence northward, the strength of the uplift diminishes; Addison ridge bends eastward and Hoop-Pole becomes ill-defined, so that the outcrops of the Chemung conglomerate gradually approach. The axis passes very near the forks of the road by R. Zigel's house in East Providence, about a mile and a half north from the Monroe line, and crosses

Brush creek in Addison's ridge just above Jackson's mill, where the dip on the west side is but 20 degrees. The axis is double here as it is further south, the western fold being slight and separated from the other by a very narrow synclinal.

Northward from Brush creek, the energy of the fold diminishes so that on the Chambersburg pike it brings up only the Catskill. It is well shown on the pike as that road passes through a narrow gorge east from the Juniata river. The fold is double here and somewhat irregular in structure. The eastern fold is the stronger and its axis passes just west from McGraw's great peach orchard. Its westerly dip is 23 degrees and the easterly dip is 50 degrees, which soon falls to 5 degrees. The place of this fold is indicated at two miles north from the pike near a new school-house, but the dips are not shown distinctly for a considerable distance on either side. The axis passes into Broad Top township near the Fulton county line, where it suddenly decreases in strength and is crossed by the Pocono at Wishart's gap.

The Wells Valley anticlinals.

The next two anticlinals at the east originate in Bedford county near the Bedford and Chambersburg pike, rapidly increase in strength as they cross Ray's hill and die out with equal rapidity after entering Fulton county. The western one may be designated as the *Wells anticlinal* and the eastern as the *Griffith anticlinal*.

Two narrow but sharp folds were seen on the Bedford pike at a little way east from the Broad Top anticlinal, one at the west end and the other at the east end of the long row of houses known as Whitehall. In these is the origin of the Wells anticlinal. The Griffith anticlinal is better defined as a strong axis, crossed by the pike just west from the tannery and showing a westerly dip of 50 degrees. Neither of these can be traced in the shales north from the pike; but they are distinct in Ray's hill and north-eastward into Fulton county, where they carry the Pocono sandstone.

The Wells anticlinal passes near where the road from Wells tannery crosses Ray's hill, and thence northward the

synclinal between it and the Broad Top anticlinal becomes very marked. The deepening of the synclinal is very rapid; for, within a distance of two miles the coal measures are shown on Broad Top mountain at an elevation somewhat less than that of the Pocono on Ray's hill. The axis of the synclinal is crossed by Sideling Hill creek very near the road leading to Wishart's coal-pit. The anticlinal is crossed by that creek at the west side of the Tannery village and carries the Pocono almost to the creek; while the influence of the fold is seen further north in the deeply notched outcrop of the *coal measures* on Broad Top mountain.

The synclinal between this and the Griffith anticlinal is crossed by the creek at but a little way below the Tannery, the western side being short. This trough rises rapidly southward. It soon becomes indistinct northward.

The Griffith anticlinal is ill-defined in the mountain mass, but is shown in Ray's hill by notches at a short distance north from the Bedford pike. No details could be gathered until within a mile of Sideling Hill creek, as the country is covered by forest. It does not carry the Pocono to the creek, which it crosses south from the Fulton institute. Northward its exact course could not be followed, but its gradual decrease is shown by the widening of the *coal measures* northward as they approach the line of Huntingdon county. This axis cuts off the *coal measures* at the east.

The structure in the Coal Measures area of Broad Top within Bedford and Fulton counties.

The Broad Top area is a wild rocky region, surrounded by a deep valley eroded in Mauch Chunk, around which is a high rim of Pocono forming Harbor or Terrace mountain of Bedford and Sideling hill of Fulton. The hard Pottsville forms the rim of the Coal Measures plateau, which is broken down only on the west side where the drainage escapes to the Juniata through the gorges of Six-mile and Sandy runs.

Many difficulties were encountered in the attempt to connect the plications of the coal area with those of the region

at the south, already described. The valley of Sherman's run affords no exposures except on the south side, so that one cannot ascertain positively whether or not new folds occur in the soft Mauch Chunk rocks. The county map is exceedingly defective, and the means at the writer's disposal did not admit of making any material corrections. Mr. L. Macdonald, the mining engineer for several of the larger companies, and Mr. John Mitchell of the Kemble Company's mines rendered much valuable assistance without which the writer's knowledge would have been much more imperfect than it is.

The basins are well shown on Six-mile, and the western basins are easily recognizable on Sandy run. The last two basins on the east are indicated on the southern edge of the area in Fulton county; but they were not followed out, as Broad Top is there an almost unbroken wilderness.

The Clear Ridge anticlinal was recognized only with doubt at the mouth of Sandy run between Hopewell and Riddlesburg, and below Riddlesburg on the Huntingdon and Broad Top railroad. A double and comparatively insignificant fold was seen at all of these places.

The Clearville synclinal includes the first and second basins of Six-mile run, the second being much the deepest basin in the area. The first basin is shallow on Sandy but the second is well marked.

On Sandy the Grey's Run anticlinal is shown in a railroad cut just below the first sharp bend in the stream, where the axis is complicated and abrupt. The easterly dip in the cut is 43 degrees. The same axis is crossed by Six-mile run just below the bridge above the Mt. Equity coal mine. The dip on the west side is gentle but the easterly dip is 45 degrees.

The westerly or Mt. Equity division of the Clearville synclinal is known as the *first basin* on Six-mile run, where it is very distinct. Its axis is crossed by the run at a few yards below the road leading to the mine. The dips on the west side are from 56 to 18 degrees, the latter very near the synclinal axis. An anticlinal is present on this stream, which is shown in the Mount Equity mine. This has a

marked influence southward, as it grows stronger in that direction, so that the first basin is lifted well up into the air and becomes insignificant before Sandy run is reached. The *Kelly coal bed* comes out to daylight within half a mile south from Six-mile at 450 feet above the mouth of the Mt. Equity mine. On Sandy this anticlinal is little more than an interruption of the dip, but it is sufficiently evident high up on the mountain side opposite the first house below the railroad cut. Its dip on the east side near the run is 55 degrees.

The eastern division of the Clearville synclinal, or the *second basin*, is the deepest in Broad Top within Bedford and Fulton counties. On Sandy creek the axis passes very near the Stone Row at the mouth of Long run. The western side is finely shown by a long line of exposures continuing from the Grey's Run anticlinal almost to the synclinal. The dip is from 45 to almost 60 degrees; and a considerable part of the Barren Measures is carried below the surface of the deeply eroded valley. No subordinate anticlinals were observed here. The eastern side of the basin is wholly concealed.

But on Six-mile the conditions are different. The dip slackens quickly as one goes east from the Grey's Run anticlinal and becomes only 18 degrees within a few rods, beyond which it quickly falls to 5 or 6 degrees. On this stream the basin is triple;

The first synclinal passes through Young's house,

The first anticlinal is at the next house,

The second synclinal is very near the store,

The second anticlinal is at the railroad crossing above the store.

The third synclinal was not definitely located.

The anticlinals are so slight that amid the poverty of exposure they are liable to pass unnoticed, yet they are strong enough to be important economically, as they suffice to interrupt drainage. The greatest dip on any of them is 10 degrees.

The basin as on Sandy run is deep, the *Kelly coal seam* being more than 200 feet below the surface on the west side;

but the general rise eastward is considerable, for at 60 rods from the Sheaver's creek anticlinal, that coal bed is at only a few feet below the run.

The Sheaver's creek anticlinal or School-House anticlinal of Six-Mile run is very distinct on both Six-Mile and Sandy. It is shown on the latter above the mouth of Long run, at the first railroad curve, where a cut exhibits its complex structure. Three folds are present within 100 feet. The westerly dips are 60, 75 and 55 degrees, while the only easterly dip well exposed is 60 degrees and belongs to the western fold. The westerly dip soon falls off to 30 degrees. An exposure on the county road shows an easterly dip of 48 degrees, but it was not possible to determine to which of the folds this belongs. The structure of the eastern fold is ill-shown, but it is extremely abrupt and the conditions suggest a slight fault.

This axis is crossed by Six-Mile run at the fork of the road near the new school-house opposite the Duval shaft, and it passes between two openings made in the *Kelly coal bed* by Reed Wilson and Company. The dip is abrupt on the easterly side, one exposure above the school-house showing 55 degrees, while, in the Duval shaft mine the coal is almost vertical near the axis. The dip on the west side appears to be gentle, being only 14 degrees at the only exposure observed.

The folds between the Sheaver's creek anticlinal and the Broad Top anticlinal cannot be identified with those occurring further south. Clearly some new folds have come in by bifurcation, so that the synclinal and complex anticlinal of Snyder's ridge cannot be recognized in detail, and local names must be applied to the folds occurring in this interval. The succession as made out is as follows :

3d. synclinal, or Duval basin.

3d. anticlinal or Duval anticlinal.

4th. synclinal or Fairplay basin.

4th. anticlinal or Cunard anticlinal.

5th. synclinal or Cunard basin.

5th. anticlinal or Round Knob anticlinal.

6th. synclinal or Round Knob basin.

6th. anticlinal or Tankhouse anticlinal.

7th. synclinal or North Point basin.

7th. anticlinal or Edge Hill anticlinal.

8th. synclinal.

8th. anticlinal, or Reed Wilson anticlinal.

9th. synclinal or Jenkins basin.

These occupy the interval between the Sheaver's Creek anticlinal and the Broad Top anticlinal, a width of $2\frac{1}{2}$ miles in the direction of the dip.

The third synclinal is not shown on Sandy run, its place being concealed. No exposures occur there within the basin to give any details ; but the distance from crest to crest of the anticlinals bounding it is very nearly the same as on Six-Mile run. No definite information respecting this synclinal could be ascertained on Long run or on the road lying north from it ; but the basin is distinct on Six-Mile, owing to extensive mining operations there. The west is the short side and the dip carries the *Kelly coal* to 100 feet below the road.

The Duval or third anticlinal is shown on both Sandy and Six-Mile, and its place was recognized on Long run by the débris of the Mahoning sandstone. It is crossed by Sandy run very near the railroad bridge above Dick's house. The axial line is concealed on both the county road and the railroad ; but the western slope is shown within a few yards by a dip of 30 degrees, while the eastern slope is shown imperfectly at a little way further east. On Six-Mile it passes between the two Duval entries immediately below Coaldale or Fairplay. It shows dips of 38 degrees east and 28 degrees west, which are distinct in the Mahoning sandstone.

In the fourth or Fairplay basin no exposures occur on Sandy. Its axis passes through Fairplay on Six-Mile. The basin is shallow, not carrying the *Kelly coal bed* under the stream.

The fourth or Cunard anticlinal is well shown on Sandy, Long, and Six-Mile runs. It is crossed by Sandy immediately below the Harriet Lane mine ; by Long run at a few rods below the Kemble Company's slope ; and by Six-Mile

opposite the Cunard shaft. It is well shown by a deep railroad cutting on Sandy, which gives the dips as 48 degrees eastward and 42 degrees westward ; but an exposure on the county road shows a westerly dip of 48 degrees. The exposure is very good on Long run, where the dips are 55 degrees westward and 25 degrees eastward, but the latter becomes 30 degrees at the slope. Where crossed by Six-Mile, the easterly dip is but 14 degrees.

The fifth or Cunard synclinal is shallow and not more than 1500 feet wide on Sandy, where it barely suffices to carry the *Kelly coal bed* under the stream. The dip eastward quickly falls from 45 degrees at the mouth of Harriet Lane mine to barely enough for drainage at a few yards in the mine, the axis passing at not more than 30 or 40 yards inside. The dip on the eastern side of the basin is barely 20 degrees. The basin is deeper on Long run and the dip on the west side is 30 degrees at the Kemble Company's slope. Northward the basin becomes much shallower, so that on Six-Mile the *Kelly coal bed* is considerably above the stream. The dip is irregular, and the basin is noteworthy on account of a fault of 30 feet which has been followed for nearly 400 yards in the headings of the Cunard mine.

The fifth or Round Knob anticlinal was seen on Sandy and Six-Mile. It is crossed by Sandy immediately above the Cambria mine, and one room in that mine passes over the arch. The dip on the westerly side is 20 degrees and on the easterly side 14 degrees, both measurements being made near the crest of the fold. The axis is crossed by Six-Mile run at about midway between the Cunard shaft and the first fork of the road. No good exposure was found here, nor is there any exposure where the axis is crossed by the road leading to Round knob.

The Round Knob synclinal or sixth basin could not be recognized on Sandy run, as no road-cuttings were seen above the Cambria mine, and the dense forest along the run affords little opportunity for satisfactory exploration. A similar condition exists on Long run, where, in addition, the county map is so erroneous that the relations of such exposures as were seen could not be determined. This

basin holds Round Knob, the highest point in the coal area, on which the *upper coal measures* are caught. The axis of this synclinal is crossed by Six-Mile run at a few rods east from Wigton's row. The basin is shallow and the *Barnet coal bed* is carried barely below the run.

The sixth or Tank-House anticlinal is crossed by Six-Mile run at a few rods above the water station on the railroad, and it passes on the east side of Round knob. The dip on the west side is 45 degrees near the axis; the easterly dip was not ascertained accurately, but it is much less.

The North Point or seventh basin is shallow and carries the *Barnet coal bed* to only a few feet below Six-Mile run. It is divided by a very gentle fold. The dips are gentle, but a well-marked fault is said to exist in a mine near the bridge over Six-Mile which has been abandoned for several years owing to the difficulty of mining. This basin is well marked southward, and its axis is crossed by the Long Run road at a little way west from the road leading to Sherman or Ground Hog valley.

The Edgehill or seventh anticlinal is crossed by Six-Mile near the Welsh church and by the road leading to Ground Hog valley at but a little way beyond the Long Run road. It is a strong anticlinal and must bring the Pottsville very near to the bed of the run. The dip was not determined on Six-Mile, but the east side on the road to Ground Hog valley shows a dip of 30 degrees.

The synclinal lying east from this is narrow and passes near the first crossing of Six-Mile run above the church.

The Reed Wilson or eighth anticlinal is crossed by the road at somewhat more than a mile from North Point and passes very near a cluster of houses belonging to Mr. R. Wilson. It is a strong anticlinal and certainly brings the Pottsville above the level of the run; but the exposures do not indicate the dip. It is crossed by the road leading to Ground Hog valley not very far from the lane leading to John Figard's house, but exposures there are so poor that the place of the axis could not be determined.

The Jenkins synclinal or ninth basin is crossed by Six-mile very near the end of the railroad above Mr. Jenkins'

mine. It is deeper than any of those lying east from the Duval anticlinal and carries the Mahoning sandstone under the surface. Most probably it is the Felten synclinal.

All of these folds strike N. 30 degrees to 32 degrees E. Usually the west side of the synclinals is very short, so that, notwithstanding the steeper eastern dip, there is a general uplifting of the beds eastward in each succeeding basin until the Reed Wilson anticlinal has been crossed and the Felten synclinal reached.

The Broad Top anticlinal appears to be double, but owing to poverty of exposures and the utter worthlessness of the map, which is wholly misleading here, details could not be obtained on Six-mile run, while the region at the head of Sandy is a wilderness, in which no points can be fixed without an instrumental survey beginning at North Point.

In ascending Six-mile above the Jenkins mine, one soon crosses that run for the last time. About midway between this crossing and a corduroy bridge over a pretty tributary to the run, the road crosses the summit of a low ridge which evidently marks the course of an anticlinal. Thence the rocks dip eastwardly to the corduroy bridge, where the road begins to climb a high ridge. The synclinal of the tenth basin is reached at the first bench on this ridge, so that at the top of the mountain the dip is westward and the rocks are rising rapidly on the side of the main division of the Broad Top anticlinal. Beyond this the exposures are indefinite, and thence eastward nothing was ascertained. The basins indicated in Fulton county along the southern part of the coal measures area were not followed out, as the region is a wilderness.

The folds between the Broad Top and Griffith anticlinals at the west and the Whip Cove anticlinal at the east.

Three folds are shown on the Bedford and Chambersburg pike in this interval.

The *McIlvaine anticlinal* crosses the pike a short distance east from McIlvaine's hotel and appears to attain its maximum importance between the pike and the old State road at the north. It brings up the Pocono abruptly and makes a

bold hill of that rock on the pike, which however extends northward to but little beyond the old State road. This anticlinal cannot be followed northward, but its influence is shown in the Emmaville basin fully three miles south from the pike, where it makes a gentle fold in the Mauch Chunk.

The Akersville anticlinal originates in the side of Town hill, the western slope of the Whip Cove anticlinal, and it is distinct to some distance north from the old State road; thence it decreases rapidly, so that before Wells valley has been reached it is covered by Mauch Chunk. Within a short distance further north it cannot be recognized. Its course is marked by a ridge of Pocono from its origin near Emmaville northward, across the pike and the State road, to beyond Mr. Nail's house on the road leading from Wells tannery to the old State road. The ridge steadily increases in height northward and attains its greatest importance between the pike and the State road.

The axis of this anticlinal is crossed by Roaring run at a little way east from Akersville; by the pike very near J. Ensley's house. Its place is not shown on the old State road, but it lies within Brush Creek township. for its eastern slope is shown on the State road almost immediately east from the township line.

The *Sprowl anticlinal* originates about midway between the pike and the road leading over Sideling hill from Akersville, north of which it is crossed by Mauch Chunk, but the Pocono is brought up quickly so as to form a mountain on the pike, where it is lost in Sideling hill as the synclinal between the Sprowl and Whip Cove anticlinals is very shallow there.

The axis of this fold crosses Wooden Bridge creek above Mr. Sprowl's house on the old State road. The gorge of that stream shows the Catskill. This anticlinal is bold on the old State road, but it decreases northward very rapidly. Sideling hill, north from Wooden Bridge creek, is its western slope, but at Sideling Hill creek near the northern line of the county the axis has become so insignificant as to be nothing more than a mere wrinkle on the west side of the Jack's Mountain anticlinal. It is crossed

by Sideling Hill creek nearly opposite O. Osborn's house below Berkstresser's mill.

The *Emmaville synclinal* has as its western boundary the Broad Top and Griffith anticlinals; for its eastern, the Whip Cove as far as opposite Emmaville, whence it is bounded by the Akersville anticlinal.

This trough is shallow at the southern edge of the district owing to the great increase in strength of the Broad Top and Whip Cove anticlinals; but the Pocono is present to the State line, though it has been removed for a little way in the vicinity of Leasure's gap near the State line. Further north, on McKee's run, the trough is so much deeper that the Catskill is not exposed along the line of the axis. Thence northward the depth increases rapidly, so that at the southern point of Brush Creek township Town hill divides into Town and Ray's hills, which contain the Pocono outcrops on opposite sides of the basin. The Mauch Chunk appears at a little way north from the "lockings" of these mountains and continues thence to within a short distance of the Bedford and Chambersburg pike. The dips are from 35 to 50 degrees and are steeper on the west side of the trough. A pretty fold follows the foot of Ray's hill, and a similar fold is shown along the west side of the Akersville ridge. The axis is crossed by Sideling creek at barely half a mile east from the county line; by McKee's run at the north-westward bend of the road above J. McKee's house; in the Brush Creek valley or Emmaville basin it passes very near Emmaville and Mrs. Sproat's saw-mill.

This basin is split by the McIlvaine anticlinal. The axis of the western division passes very near to McIlvaine's hotel, while the eastern and more important is crossed by the pike very near the road leading northward to the State road, and it is crossed by that road near Mr. Ensley's house. Its place is well shown by a short ridge. Everything is concealed along the State road. Beyond that the trough again deepens into the

Oregon synclinal, where it holds Mauch Chunk in the area drained by Elbow run and Oregon creek. Here it soon becomes continuous with the trough between the Akersville

and Sprowl anticlinals, all traces of the former anticlinal being lost.

The *Duval synclinal* is distinct only in Brush Creek township and in Wells as far north as the old State road. It separates the Akersville from the Whip Cove anticlinal. The Mauch Chunk has been removed by erosion south from the road leading across Sideling hill from Gapsville, but the trough deepens quickly north from that road and the Mauch Chunk soon appears. This trough is split by the Sprowl anticlinal. The western division is crossed by the State road near the first fork west from Sprowl's, where it holds only Pocono. It cannot be followed in detail further north, as the whole region is uncleared for a considerable distance; but it deepens rapidly and holds Mauch Chunk before reaching Mr. B. Greenland's house. The eastern division cannot be traced beyond the Bedford pike, as erosion has removed much of Sideling hill. No exposures occur in the Catskill beyond that, as everything is deeply covered by débris from the Pocono.

The Whip Cove and Jack's Mountain anticlinals.

These anticlinals are so closely related that they must be described together.

The Whip Cove anticlinal, entering Fulton county from the south, is crossed by Buck Lick run near J. Potter's house; by the Hancock road near the German Lutheran church; by the road following McKee's run at a little way west from Buck Valley post-office; it passes very near the Winter school-house in Brush Creek township. Passing into Belfast township, it was recognized on the road leading over Sideling hill from Gapsville; it was seen on the Bedford and Chambersburg pike at not more than 100 rods east from the line of Brush Creek township. Thence northward it could not be traced, there being no exposures along its line for three miles. Beyond that, no evidence of the fold exists.

But where the Whip Cove anticlinal begins to decrease, a new anticlinal originates in Belfast township. This is insignificant in that township, but it is distinct west from Mrs. Clark's saw-mill in the south-west part; it is shown in

the northern part of the township between Sipes Mill post-office and Wink's mill ; it is clearly present at a little way west from J. Strait's house on Sideling branch of Licking creek in Licking Creek township ; but its place is wholly concealed on the Bedford and Chambersburg pike in the same township. Thence northward it increases quickly and becomes a strong anticlinal. It is crossed by the State road at G. S. Chestnut's house ; it passes at about 100 rods west from Taylor chapel on the road leading from Hustontown to Waterfall mills ; and it is crossed nearly midway between A. and B. Bollinger's houses on the road leading from Waterfall mills to Clear Ridge post-office. This is the Jack's Mountain anticlinal which forms a bold mountain in Huntingdon county.

The Whip Cove anticlinal is very strong in Bethel township, and the widely separated outcrops of Pocono form Town and Sideling hills. Exposures are incomplete in the southern part of the township, so that one cannot determine whether there are more than one flexure in the fold. But there is every likelihood that several flexures exist there ; for, though the cove is more than three miles wide and the dip is often abrupt, yet no rocks lower than the topmost beds of the Chemung are brought up where the fold is cut by Buck Lick run. But the fold is certainly complex along McKee's run, where two anticlinals were recognized within the cove. The energy of the fold diminishes in Brush Creek township and only one anticlinal was seen. Thence northward the fold is single.

In Union township this axis brings up the Catskill forming Whip cove ; but the cove becomes narrower northward from McKee's run until the Pocono outcrops unite at the "lockings" of Sideling and Town hills, where that group crosses the fold. The anticlinal is easily traced in Belfast township, for forks of Little Tonoloway and Cumming's run, heading within Sideling hill, have eroded long gorges along the anticlinal line, thus making the west ridge of Sideling hill a monoclinal, while the eastern ridge is a synclinal. This distinction is well marked northward into the southern part of Licking Creek township, but thence almost

to the Bedford and Chambersburg pike it is ill-shown. So clearly distinct are these ridges that the western one is often spoken of as Town hill while the eastern is known as Sideling Hill, although the "locking" of the two ridges is distinct at the south-west corner of Belfast township. The Catskill is reached by erosion at the headwaters of several streams within Belfast township.

The Jack's Mountain anticlinal is crossed by the Catskill in Belfast, Licking Creek and Southern Taylor; but at the old State road it brings up the highest beds of the Chemung. Within a mile further north the two ridges of Chemung conglomerate are distinct; at three miles, those ridges are one mile, and at the county line somewhat more than a mile and a half apart.

The growing influence of the Jack's Mountain anticlinal cuts off the Pocono, so that where the Whip Cove anticlinal disappears it is covered with Catskill.

The Franklin Mills and Pigeon Cove anticlinals.

Under these names the writer includes a group of folds, which, as such, enter the district from the south, but diminish northward, until, at the southern edge of Licking Creek township, the whole series is represented by but a single fold, which disappears at a little way north from the Bedford and Chambersburg pike. The subdivision is best shown in Bethel township, where the Franklin Mills folds affect only Devonian, while the Pigeon Cove folds bring up the Lower Helderberg.

On Tonoloway creek, beginning at Franklin Mills, two distinct anticlinals are shown before Tonoloway Ridge has been reached, both bringing up the Portage flags and showing abrupt dips. Five anticlinals were seen in the Lower Helderberg of Pigeon cove, a strong one on each side in Tonoloway and Stillwell's ridges, while three petty folds pass through the hamlet of Warfordsburg. The stronger folds are distinct at a mile and a half further north in the cove, as well as at two thirds of a mile south from the line of Belfast township. Only two of the Franklin Mills folds

were seen in Northern Bethel, but three are shown in the southern edge of Belfast township.

Northward from Needmore both sets of axes become simple, so that on Little Tonoloway each is represented by but a single anticlinal; the Franklin Mills being crossed opposite M. Starr's house; the Pigeon Cove at the mouth of Foster run. Exposures are very indistinct along the southern edge of Licking Creek township; but, there, the whole series seems to be represented by but a single fold passing at a little west from S. Truax's house. Only one fold exists on Sideling Hill branch of Licking creek, and is crossed by that stream just above Dishong's old mill; while the same fold is crossed on the Bedford and Chambersburg pike immediately west from the Greenhill church. It disappears at a short distance further north.

The Franklin Mills group shows less variation than the other. It brings up the Portage flags on Tonoloway, Barnets, Hart's, Cumming's, Little Tonoloway, Sideling Hill branch and the pike, with abrupt dips everywhere; but the Pigeon Cove group decreases rapidly from the State line to the middle of Belfast. At the State line an interval of three miles separates the Oriskany outcrops; immediately beyond the Belfast line those outcrops have united, and at Needmore the Marcellus crosses the arch. At Foster's run Portage is the lowest rock exposed, and there the dips are very abrupt. Thence northward Portage is shown along all the streams, but the arch is crossed by yellow shales on the higher land.

The Black Log anticlinal.

This axis was recognized first in Licking Creek township on Sideling Hill branch of Licking creek, which crosses it at Dishong's mills. There the fold is irregular with varying dips and brings up the Portage. It is equally irregular on the Bedford and Chambersburg pike, where it is represented by three petty folds west from Harrisonville. It shows little increase in strength within this township, and it is represented by two folds in the south-west corner of Dublin township which bring up nothing older than Port-

age. But after entering Dublin it develops quickly, so that the Hamilton appears north from Licking creek, while at less than a mile north from Fort Littleton the Medina outcrops form Black Log and Shade Mountains. The divergence of the Oriskany outcrops shows the rapid development of the fold.

The synclinal between Jack's mountain and Black Log anticlinals lies very near Wooden Bridge creek in Taylor township, and throughout that township it holds Catskill. That between Black Log and Pigeon cove in Licking creek holds nothing higher than upper Chemung.

The Scrub Ridge synclinal.

At the south this is the synclinal between the Pigeon Cove anticlinal and the anticlinal of McConnell's cove; but further north it becomes the basin between Black Log and the Cove anticlinal. It occupies part of Thompson, Belfast, Licking Creek, Ayr, Todd, and Dublin townships. The Timber ridge of Belfast and Thompson lies within this basin.

Scrub ridge synclinal holds the most easterly fragment of Pocono and Mauch Chunk found in southern Pennsylvania. Pocono outcrops form Scrub ridge and Meadow Ground mountain, while Mauch Chunk occupies the saddle between them. The ridges of the Chemung upper conglomerate are well shown on both sides of the basin.

The axis of the Scrub Ridge synclinal cannot be traced accurately, but the main course is easily recognized by the topography. The trough is narrow near the State line; near the northern border of Thompson it widens, the widening continuing throughout Ayr and Belfast; but beyond the northern line of Belfast the width decreases; and in Dublin township the depth of the trough is greatly diminished. At the State line, the trough holds Catskill; the Pocono is reached first near the northern edge of Thompson; and the Mauch Chunk is wholly within Ayr. At the Huntingdon line the trough holds no rocks newer than middle Chemung.

The Cove fault.

This interesting phenomenon deserves some special reference here, though all the details obtained are given in the chapters on Ayr, Todd and Dublin townships of Fulton county.

This fault originates in Dickey's mountain at probably one mile south from Big Spring run, and continues thence for about 11 or 12 miles in a rudely northern direction to within somewhat more than a mile of the Huntingdon county line, where it is lost amid the Devonian shales. It crosses the general strike of the rocks, so that in going northward from Dickey's mountain it cuts off the high groups in succession and after reaching the undisturbed portion of Little Scrub ridge it cuts off the same groups a second time. This condition is due to the semi-oval form of outcrops on the west side of the Cove anticlinal.

From the origin of the fault to where it passes into the Clinton on the northwest side of Little Scrub ridge it holds in its jaws the upper beds of the white Medina. This rock forms a projecting wall from 50 to 200 feet wide. It forms Lowrie's knob, the northern point of Dickey's mountain; thence for half a mile it is missing; but, soon re-appearing, it is readily traceable to the Bedford pike as a low irregular ridge. At the pike it becomes a high ridge, and thence, as part of Little Scrub ridge, it can be followed by its jagged crest to where the fault passes beyond the Medina of that ridge.

To trace the fault to its origin in Dickey's mountain is impossible, for the eastern slope of that ridge is deeply covered by Medina débris; but the features are distinct on Big Spring run, where it breaks through the mountain, for there the massive beds of the Lower Helderberg are exposed at barely 500 feet west from the Medina wall, showing that the fault has swallowed the Clinton. The Medina is dipping eastward at 60 to 80 degrees and only a small part of the white Medina is shown, for the Lower Medina, succeeded by Hudson, lies immediately behind it. The whole exposure of Hudson and both Medinas is too small for lower Medina alone. So that much of the lower Medina has been

swallowed, while this fragment of Upper Medina is a wedge in the crevice.

Spring Valley run crosses the fault at less than a mile north from this gap. There the Medina is wanting and the Marcellus is in contact with the limestone of Formation II. The beds are dipping in each case away from the fault. A lane leading past W. Kendall's house crosses the fault at less than a mile north from Spring Valley run. There the drab shales of the Marcellus are shown on the west side of the wall, while the limestones of No. II are exposed within a few yards from the Medina on the east side. A similar dip is shown by the limestone at half a mile further north, but it soon ceases, for at the next crossing of the fault, barely a mile and a half north from the Kendall lane, the limestone dips toward the fault to within 3 rods of the Medina wall, while on the west side of that wall are the upper beds of the Portage flags. Here the base of the Clinton group appears to form part of the wall.

Northward from this, the fault enters the rocks of Little Scrub ridge; for, on the east side the Hudson and Utica shales are seen dipping toward the fault, which is still marked by the nearly vertical wall of Medina; on the west side, the yellow shales which underlie the lower conglomerate of the Chemung are shown. This exposure is on J. S. Pittman's lane, about one mile north from the last locality.

The next exposure is one mile further north, on the road from the Bedford pike to Meadow Ground mountain. There the Medina wall is very near the lower conglomerate, so near, that débris from the two beds is mingled in the fields.

Thus far the fault has followed a direct, unbroken line, but at the pike its course is bent somewhat more towards the east, while the trend of the Devonian rocks, owing to the shallowing of the Scrub Ridge synclinal, is pushed westward. The next exposure is at somewhat more than a mile north from the pike. The limestones of II and the shales of III are dipping toward the fault, while on the west side of the nearly vertical Medina wall are yellow shales belonging near the lower conglomerate of the Chemung.

No further exposure was found until Hershey's gap was reached, nearly four miles further north. There the Portage flags are shown on the west side with inverted dip, dipping eastward toward the Medina wall. A part of the lower Medina is shown in the gap and further east are the Utica shales. The Medina wall disappears within two miles north from this gap; and two miles further, where the old State road crosses the fault, the Hamilton is seen in contact with Chemung beds belonging near the Upper Conglomerate, both groups dipping toward the line of fault. Beyond this, northward, the fault cannot be traced.

The Cove anticlinal.

The anticlinal of McConnell's cove is a strong fold within Fulton county, but its energy diminishes in each direction from the middle line of Ayr township. It brings up the limestones of Formation II in the Cove. Cove and Tuscarora mountains limit the Cove on the east, while Dickey's mountain and Little Scrub ridge make up the boundary on the westside. These are bold Medina ridges. Cove mountain and Little Scrub ridge "lock" at one third of a mile south from the Huntingdon county line and Clinton crosses the arch at that line; Tuscarora and Dickey's mountains "lock" at somewhat more than a mile north from the Maryland line. There the fold ends more abruptly than at the north, for Chemung beds are shown at the State line.

The axis of this anticlinal passes at nearly 150 rods east from the Clarkson cross-roads on Big Spring run; very near F. W. McNaughton's house on Spring Valley run; near W. A. Kendall's house on Kendall's run and through the borough of McConnellsburg, east from the road leading to the Cove tannery. Exposures are indefinite throughout the Cove, and the place of the anticlinal cannot be fixed at any place within 400 feet.

The synclinal of Allen's Valley.

Cove and Tuscarora mountains, both Medina ridges, "lock" at about a mile and a half north from the pike.

Thence they diverge to the Huntingdon line. Allen's valley, in which Little Aughwick creek heads, lies between them. It holds only Clinton shales within Fulton county. Exposures are almost wholly wanting in Fulton county.

CHAPTER III.

The Carboniferous Rocks.

In this report the Carboniferous is understood to include the Coal Measures, the Pottsville, the Mauch Chunk and the Pocono formations.

The Coal measures, No. XIII.

This group occupies only a small area in the north-east corner of Bedford and the adjacent portion of Fulton county. The rocks in great measure are sandstone, so that for the most part the region is rugged, uncultivated, and covered by a dense forest. The folds are numerous and narrow, so that, without the aid of extensive explorations made by mining companies along Six-Mile and Sandy runs the geologist would be at a great disadvantage. As it is, the work performed by the writer is at best but tentative, and much yet remains, which can be done only after an accurate topographical map of the area has been constructed.*

As far as ascertained, the following is the generalized section :

Broad Top general section.

1. Not exposed ; top of Round knob, . . .	100'
2. Coal bed, seen,	1' 4"
3. Not exposed,	40'
4. Limestone,	12'
5. Concealed,	200'
6. Coal bed, blossom seen said to be,	5'

*In 1855 and 1856 Prof. Lesley made a topographical survey of the Broad Top as a basis of his geological surveys of special tracts; but the map was never quite finished and requires additional field work before it can be published as part of the report of the Survey. More than 11,000 level stations were determined and most of the relief portrayed. Underground work was also done and all then existing collieries delineated.

7. Ill-exposed,	425'	
8. Sandstone,	50'	
9. <i>Speer coal bed</i> ,	1'	to 10'
10. Clay,	3'	
11. Sandstone,	40'	
12. Shale,	0'	to 10'
13. <i>Kelly coal bed</i> ,	13' 10"	to 5'
14. Shales and sandstone,	120'	to 65'
15. <i>Twin coal bed</i> ,	1'	6"
16. Clay,	2'	
17. Sandstone,	28'	
18. <i>Barnet coal bed</i> ,	5'	to 1' 9"
19. Clay,	9'	to 3'
20. Sandstone and shale,	50'	
21. <i>Cook coal bed</i> ,	6'	to 2'
22. Clay,	3'	
23. Pottsville sandstones.		

The highest beds are reached only on Round knob and possibly in the second basin on Six-Mile run. Round knob is a lofty point between Six-Mile and Long runs. The highest *coal bed* of the section has been prospected on Round knob by Mr. Wigton, who finds it to be of the thickness given; but Prof. Lesley states that, some years ago, he saw an exposure of the bed which amounted to fully 7 feet. The coal is worthless in the Wigton pit.

The interval No. 3 is not exposed, but limestone lies very close to the *coal bed*, for large pieces are at the mouth of the drift, which Mr. Wigton says were obtained while taking up the bottom for a trackway. How far this extends downward cannot be ascertained. In any event, the limestone of Nos. 3 and 4 seems to represent the great limestone series of the *Upper Coal Measures* of south-western Pennsylvania, which would make *coal bed* No. 2 very near the horizon of the *Washington coal bed*. The *Uniontown bed* is but 165 feet above the *Pittsburgh* in the Salisbury basin.

No exposure aside from 5 feet of shale was found in the interval No. 5. The *coal bed* No. 6 is known locally as the *Pittsburgh coal bed*, and there appears to be no reason for doubting the accuracy of the identification. No openings in this bed are worked, but Mr. Wigton has prospected it and he reports the thickness as five feet with four feet of coal. This is supposed to be the same with a bed found in

the second basin on Six-Mile at somewhat more than 400 feet above the stream. But the opening there was merely a prospecting pit, which has long been closed.

The interval No. 7 is practically concealed. The greater part of it is above the run in the second basin as well as in the Round Knob basin, but exposures are very indefinite, and the relations of such fragmentary exposures as were found in the sub-divisions of the second basin could not be determined satisfactorily. Midway in the section is a *coal bed* which was once prospected on Six-Mile near the eastern edge of the second basin, but the opening had fallen shut and there seems to be some doubt as to the exact spot where the opening was made. A small bed is shown at the road side, on the western side of the basin, which is double and somewhat more than 2 feet thick. According to Mr. Mitchell, the distance from this bed to the *Pittsburgh bed* in this basin is 400 feet as determined by spirit level. The greater part of the interval is occupied by shales or shaly to flaggy sandstone. The thickness of the interval, as given, is merely approximate, as the exact geographical relation of the localities between which the barometric levels were made could not be determined with the means at the writer's disposal.

Nos. 8 to 11 represent the Mahoning sandstone, which here as at most localities further west is double, with a *coal bed* between the plates of sandstone. The upper division, No. 8, is light gray, mostly coarse-grained and sometimes distinctly conglomerate. It is a marked feature at many localities on Six-mile run and it forms the wall on Sandy at the mouth of Long run. The *coal bed* No. 9 is known locally as the *Speer coal bed*, sometimes as the *Twin*. It is equivalent to the *Gallitzin coal bed* of Mr. W. G. Platt's Cambria Report. Usually it is of little value and the section is :

<i>Speer coal</i> ,	<i>Coal</i> ,	1'
	<i>Clay</i> ,	2
	<i>Coal</i> ,	1' to 6''

But on Sandy, below the mouth of Long run, it is much thicker. There it has been subjected to severe pressure during the folding of the rocks, so that it and the adjacent

clays have slipped on each other. The *coal* occurs in pockets 1 to 10 feet thick and it is broken into lenticular fragments with perfectly glazed surface. The *coal* is mined for local use and is much liked at Hopewell, the terrible crushing having had no effect on its quality as fuel, though rendering it inconvenient to handle and so destroying its value for shipment. The thickness of the overlying clay shale was not ascertained.

The interval No. 2 is occupied usually by sandstone. It is well shown on Sandy below the mouth of Long run as well as in the Cunard basin, where it is flaggy. The thickness in the first basin on Six-Mile is barely 10 feet, for the whole interval from the *Speer coal* to the *Kelly* is but 20 feet as ascertained in an air shaft at the Mt. Equity mine.*

The *Kelly coal bed* is exposed at several localities on Six-Mile, in the Cunard and Round Knob basins on Long run and in the Cunard on Sandy. It shows some noteworthy variations in structure. The section at the Mount Equity mine is :

		Mt. Equity.
<i>Kelly coal,</i>	1. Coal, upper bench, . . .	2' 1"
	2. Parting.	
	3. Coal, bearing-in bench, . . .	0' 7"
	4. Parting.	
	5. Coal, middle bench, . . .	1' 2'
	6. Parting.	
	7. Coal, lower bench, . . .	1' 2" to 0' 10"
	8. Clay,	2'
	9. Coal,	0' 4"

But in the Duval basin the structure is wholly different and the change is shown also in the Cunard basin. The sections seen in the Duval mine and the Cunard mine may be compared ;

		Duval.	Cunard.
<i>Kelly coal,</i>	1. Coal, upper bench, .	2' 5"	2' 11"
	2 Parting,	0' 0" to 3"	0' 0" to 7"
	3. Coal, lower bench, .	1' 7"	1' 0"
	4. Clay,	1' 3"	
	5. Coal,	0' 0 $\frac{1}{2}$ "	
	6. Clay,	0 10"	
	7. Coal,	0' 0 $\frac{1}{2}$ " to $\frac{1}{8}$ "	

* There is some room for doubt respecting the accuracy of my identification of this coal bed with the *Speer*. But no other coal bed has been discovered here above the *Kelly*.

Here both the bearing-in and the Middle bench are absent and the only available *coal* is in the Upper bench, the Lower bench being worthless at all exposures.

The structure in the Cunard basin on Long run is very simple. The whole bed as exposed in the Kemble Company's slope being only from 4 to 16 inches thick ; but in the Round Knob basin on the same run, the section is different from that seen elsewhere, being as follows :

<i>Kelly coal</i> ,	{	1. <i>Coal</i> ,	0' 10"
	{	2. <i>Bone coal</i> ,	0' 2"
	{	3. <i>Coal</i> ,	2' 4"
	{	4. <i>Black shale</i> ,	0' 2"

The bed is well exposed in the Cunard basin on Sandy, where it shows an upper division which is either concealed at all exposures on Six-Mile or is absent there. The sections obtained at the Cambria and Harriet Lane mines are compared :

		<i>Cambria.</i>	<i>Harriet Lane.</i>
<i>Kelly coal</i> ,	{	1. <i>Coal</i> , upper division, . . . 5'	1' to 4"
	{	2. <i>Shale and clay</i> , . . . 2'	10' to 1"
	{	3. <i>Coal</i> , upper bench, . . . 2' 3"	1' 10"
	{	4. <i>Parting</i> .	
	{	5. <i>Coal</i> , bearing-in bench, . . 0' 7"	0' 7"
	{	6. <i>Parting</i> .	
	{	7. <i>Coal</i> , middle bench, . . . 1' 8"	1' 5"
	{	8. <i>Bone coal</i> , . . . 0' 1"	
	{	9. <i>Coal</i> , lower bench, . . . 2' 3"	3' to 1"

This twinning is persistent in both of these mines, which are extensive. The *Kelly coal bed* is apparently equivalent to the main *Upper Freeport coal bed* of western Pennsylvania.

The interval between the *Kelly* and *Twin* beds shows much variation. On Six-mile, its thickness is from 118 feet in the first basin to 75 feet in the Cunard basin ; while at the only exposure on Sandy it is 65 feet. It is occupied mostly by shale in the Cunard shaft ; but in the first basin, as shown by the Kemble Company's boring, it contains much sandstone. A very coarse sandstone occurs here, apparently about midway between the beds, which is exposed south from Six-Mile. On Sandy, the interval is filled with sandstone, more or less flaggy at the top but becoming massive below.

The *Twin bed* is unimportant. It is a single bed, without parting and its thickness rarely exceeds 18 inches.

The interval between the *Twin* and *Barnet* varies abruptly on Six-Mile in the first basin, being 37, 19 and 7 feet in 200 rods. It is 30 feet in the Cunard shaft and 17 feet on Sandy below the mouth of Long run. Except the thin clay bed under the *Twin* sandstone, the rock is sandstone.

The *Barnet coal bed* is exposed at many places along Six-Mile, but it is exposed on Sandy only in the second basin. Like the *Kelly* it varies greatly. It is from 2 to 5 feet in the first basin on Six-Mile, where it is not mined. Its structure in the Cunard shaft is :

<i>Barnet coal</i> , {	1. Bone coal,	0' 10" to 3"
	2. Coal,	2' 8"
	3. Shale,	0' 8" to 6"
	4. Coal,	0' 10"

while in the North Point basin it shows :

<i>Barnet coal</i> , {	Bone coal,	0' 4" to 3"
	Coal,	1' 10" to 1' 6"

But an imperfect exposure on Long run in the Round Knob basin shows :

<i>Barnet coal</i> , {	Bone coal,	0' 6"
	Coal,	3' 6"

The bone coal on top characterizes this bed everywhere and is as well marked at the Wishart mine in Fulton county as in the first basin on Six-mile run.

Fire clay underlies the *Barnet coal bed* and is from 3 to 9 feet thick. It contains kidneys of clay-iron stone some of which weigh one fourth of ton.

The interval from the *Barnet* bed down to the *Cook coal bed* varies from 8 feet in the Cunard shaft to 50 feet on Sandy run and in the North Point basin on Six-mile. It is filled with clay and shale in the Cunard shaft but with sandstone on Sandy.

The *Cook coal bed* varies from 2 feet to 2 feet 6 inches in the first basin on Six-Mile. Its section in the Cunard shaft shows two benches of coal, each 18 inches, separated by 6 inches of clay ; but the bed is represented only by carbonaceous clay in a shaft near North Point ; while just beyond

that, it is said to reach 7 feet. At one time, the bed was worked on Sandy where the thickness is said to be nearly 3 feet.

Pottsville conglomerate, No. XII.

This group is shown in the extreme south-west portion of Bedford county on Wills creek and northward for probably somewhat more than a mile. In the Broad Top area it forms the rim of the Coal Measures and caps the ridge forming the inner wall of Ground Hog and Wells valleys. It underruns Sandy at barely a mile from the river, and Six-Mile at a little way below the Mt. Equity mine.

The thickness of the group on Six-Mile run is not far from 250 feet. It is no longer exposed there in detail, but at one time was fully exposed to secure measurements. A section of the upper portion was obtained on Sandy run as follows :

<i>Pottsville,</i> <i>No. XII,</i>	1. Sandstone,	121'
	2. Coal bed,	0' 10" to 2"
	3. Sandstone,	18'
	4. Coal bed,	0' 2"
	5. Sandstone,	20'
	6. Shale,	5'
	7. Sandstone,	5'

The sandstone No. 1 is fairly well shown on Sandy run, where it is light gray and by no means very coarse. It contains an irregular *coal bed* on Six-Mile, which is 2 to 8 inches thick and at 25 feet below the *Cook coal bed*. This seam was not seen elsewhere.

The petty *coal seam* No. 2 perhaps represents the *Mount Savage coal bed*. It was not seen on Six-Mile, its place being concealed, but it has been prospected near the *Wishart coal mine* in Fulton county, where it is said to be 10 inches thick.

Imperfect exposures of the lower division of the Pottsville occur at many places along the southern edge of the area, but they afford few details. The whole thickness of this division appears to be not far from 125 feet within Fulton county, where for the most part the rock is comparatively fine in grain, but contains layers of very coarse con-

glomerate.* The passage to the underlying Mauch Chunk red shale is gradual, as is well shown on the road leading from Hopewell to Riddlesburg in Bedford county.

The exposures on Wills creek at the line between Bedford and Somerset counties are imperfect, but suffice to indicate well the character of the group. The section is

Pottsville, No. XII,	{	1. Conglomerate, estimated at	75'
		2. <i>Mount Savage coal bed</i> ,	4'
		3. Shale,	5'
		4. Fireclay, from 0' to	20'
		5. <i>Coal bed</i> ,	0' 8"
		6. Shale estimated at,	5'
		7. Conglomerate, estimated at,	80'

No. 1 contains much conglomerate with pebbles as large as a pea. Several layers are composed of pebbles smaller than buckshot, which are cemented by a small amount of silica. Impressions of *sigillaria* are present.

The *Mount Savage coal bed* is no longer exposed, as the coal proved to be very inferior. The bed is broken by many thin and pyritous slates. The fire-clay is that mined to supply the brick-works at Hyndman and Keystone. It contains numerous concretions of iron ore. The lower *coal bed* is unimportant. The lower plate of the conglomerate is pebbly but less coarse than the upper plate. The top 25 feet are well exposed.

[* The geology of the Pottsville conglomerate, No. XII, is now accurately known over all northwestern and northern Pennsylvania. Its thickness is generally about 300', and its triple division seems to be constant. In the northwest it consists of *Homewood* sandstone at the top, *Connoquenessing* sandstone in the middle, and *Sharon* conglomerate at the bottom. Coal shales, coal beds, and sometimes limestones, intervene between these sub-divisions. (See Reports Q, Q², Q³, H⁴, V, V², R, and G⁴.) The three divisions of XII are known in the counties east of Warren as *Johnson's run*, *Kinzua* sandstone, and *Olean* conglomerate, and the Coal-measure intervals continue eastward to the Anthracite region, where XII becomes 600' and 1,000' thick, and holds numerous coal beds, some of them important. At Shamokin the triple division is strongly pronounced.

Adding 170', the thickness of the upper division (page 65) to 125' the presumed thickness in Fulton county of the lower division, we have 295'.

Mr. Ashburner in Report F, page 191, divides XII into an upper member 100', a middle member 40', and a lower member 80'; total 220'.—J. P. L.]

This sub-division of the conglomerate is constant as far west as Laurel Hill, between Fayette and Somerset counties, along the southern border of the State; and the *Mount Savage coal bed* is shown at Ohiopyle in Fayette county.

The Mauch Chunk red shale, No. XI.

As the rocks of this group are softer than those of the Pottsville above and of the Pocono below, its place is marked topographically by valleys. It occupies a deeply eroded trench surrounding the Broad Top coal field; a small area in eastern Fulton occupies the saddle between Big Scrub ridge and Meadow Ground mountain; the northern outcrop of the group in the Savage mountain synclinal falls within the south-west corner of Bedford county.

Very good exposures of the group occur along the Juniata; only fragmentary exposures occur elsewhere, those on the Meadow Ground barely sufficing to prove the group present. No detailed section was made at any locality, but the thickness of the group was estimated at from 1050 to 1100 feet on the Juniata and 1125 feet on Wills creek. Mr. Ashburner succeeded in obtaining a detailed section within Huntingdon county at a little distance north from the Fulton county line. His grouping is as follows:

<i>Mauch Chunk,</i> <i>No. XI.</i>	{	XIc. Sandstones and shales, red, gray, and yellow,	910'
		XIb. Red and gray shales and limestones,	49'
		XIa. Variegated shales and sandstones,	141'
			<hr/> 1100'

This grouping is sufficiently distinct within Fulton county in Wells valley and in the Emmaville basin, where the succession is clearly shown, the only difference being that the lower division is much thinner; but exposures are defective elsewhere.

The *upper division* usually contains iron ore and *coal beds* or beds of carbonaceous shale near the top; but no traces of these were found at the only locality where the upper 200 feet of the group are exposed. This portion is well shown on the country road leading from Hopewell to Riddlesburg. No detailed exposure occurs on Wills creek

until 260 feet below the Pottsville ; thence for 140 feet are alternations of shales and red argillaceous sandstones, the latter often containing nodules of indurated clay so numerous at times as to give the rock a conglomerate structure.

The *middle division* is wholly concealed on Wills creek, where, indeed, the existence of the limestones is unknown ; but these must be present, for, further west, this division attains great importance, thickening rapidly, while the overlying shales become thinner. Mr. Ashburner's section of this division is as follows :

1. Red shaly limestone,	3'
2. Red argillaceous shale,	10'
3. Soft red argillaceous shale,	5'
4. Massive, silicious red limestone, fossiliferous,	2' 6"
5. Very soft red shale,	2'
6. Red and gray calcareous shale, fossiliferous,	3'
7. Red calcareous shale and limestone,	9'
8. Red and gray massive limestone,	1'
9. Gray massive limestone,	3'
10. Red shale,	6'
11. Greenish-gray argillaceous limestone,	4'
	<hr/>
	49'

At New Grenada in Fulton county the thickness is 25' as determined in an oil-boring.

This division is frequently exposed along the road leading from Emmaville to the Bedford pike ; but, owing to the indifferent exposures and the presence of petty anticlinals, its thickness could not be determined. No quarries were found, but the limestone is gathered from the outcrops and burned for agricultural use. This division is not shown in detail along the Juniata, but it is present and appears to be represented only by red limestone and red shale. No fragments of the gray limestone were seen. The red limestone is present on the Meadow Ground where it has been utilized for agricultural purposes.

The *lower division* consists almost wholly of blood red shale along the Huntingdon railroad and along Sherman's run. It is wholly concealed along Wills creek. It contains brown hematite and manganese very near the base. This ore has been mined on Sherman's run. Loose pieces of brown hematite were seen on the Meadow Ground ; and the

ore was mined extensively at one time on the Juniata to supply old Hopewell furnace.

The Pocono sandstone, No. X.

Topographically considered, this is one of the most striking groups of the whole column. It is emphatically a mountain-maker. It caps the Allegheny mountain, Savage mountain, Ray's hill, Harbor mountain, and Allequippa mountain in Bedford county; Town hill, Sideling hill, Big Scrub ridge and Meadow Ground mountain in Fulton county. As a whole, it is a sandstone, varying from fine-grained to conglomerate. No detailed measurements could be obtained in Fulton county, but Mr. Ashburner, in making an instrumental section across Sideling hill along the East Broad Top railroad in Huntingdon county, was enabled to separate the group into well-marked divisions as follows:

East Broad Top section.

<i>Pocono, No. X.</i>	{	Xd. Upper gray sandstone group,	610'
		Xc. New River coal series,	313'
		Xb. Middle conglomerate group,	380'
		Xa. Lower green sandstone group,	830'
			<hr/> 2133'

Mr. Ashburner gives a detailed section of each division. Xc is of interest in that it contains 19 streaks or beds of *coal* from 1 to 9 inches thick.

This section differs both in thickness and details from those obtained by the writer in the gaps made through Allequippa mountain by Yellow Creek and the Juniata, while these in turn show material differences. The measurements along the Juniata are:

Allequippa mountain section.

1. Sandstone, 620'
Gray to light gray, many layers pebbly and irregularly bedded; very little shale. Two inches of *carbonaceous* shale were seen at 320 feet from the base with much carbonized wood in the adjoining layers. The rock is flaggy near the top, where it has lumps of brown hematite.
2. Red shale, 70'
3. Sandstone, 45'

4. Shale with some irregularly bedded sandstone, . . .	248'
5. Sandstone,	125
More or less flaggy and irregularly bedded, gray to brownish gray, contains conglomerate layers, 2 to 8 inches thick composed of balls of red shale and nodules of brown hematite in fine sand.	
6. Sandstone and red shale in alternate beds of nearly equal thickness,	257'
	<hr/>
	1365'
	<hr/>

The measurements on Yellow creek are as follows :

Yellow creek section.

1. Sandstone,	736'
2. Shale,	140'
3. Sandstone with ferriferous conglomerate,	87'
4. Shale and sandstone,	70'
	<hr/>
	1033'
	<hr/>

With a concealed interval, stratigraphically, of 870 feet to the first exposure of Catskill. It should be understood that the measurements in all these sections by the writer were obtained by pacing, so that an instrumental survey may change the figures somewhat.

No details could be obtained respecting this group on the west side of the district. Petty exposures occur along the crest of the Allegheny Mountain; those along Wills creek in the Little Allegheny mountain are very imperfect. The total thickness on Wills creek is not far from 920 feet, or including the silicious limestone on top, 930 feet. But this interval may be too great, as a horizontal distance of 2275 feet affords only rare exposures and the rate of dip on which the calculation is based is taken from the lower part of the group, toward which the rate increases. Possibly also a part of the Catskill is included in the estimate.

The *coal beds* observed in the East Broad Top Railroad's tunnel through Sideling Hill were not seen in the district, but a thin bed of *coal* on the road crossing Sideling Hill from Akersville to Sideling Hill branch of Licking creek belongs in this division. *Coal*, however, occurs in all divisions of the Pocono. At New Grenada in Fulton county, a boring for oil was made several years ago, beginning in the

Mauch Chunk. In this boring the lower division of the Mauch Chunk as observed by Mr. Ashburner is absent and the limestone rests directly on the Pocono. At one hundred feet below the Mauch Chunk limestone, the driller reported three beds of *coal* within 9 feet. The total thickness of *coal* was given as 8 feet. Some of the coal was pumped out and tested at the village blacksmith shop where it was found to be of excellent quality. It is not impossible that coal of this thickness may occur here, but it is in the highest degree improbable. Certainly the deposit, if such there be, is a mere pocket, for it is not exposed at the head of Sideling Hill gap nor are there any traces of it there.

Coal occurs at approximately the same horizon at the foot of Allequippa mountain opposite Riddlesburg in Bedford county. Mr. Lauder, of the Kemble Coal and Iron Company, states that while sinking for the piers of a bridge on the west side of the Juniata there, three *coal beds* were found within a vertical space of 10 feet. Their thickness varied little from 2 inches. Mr. Isaac Evans of Hopewell on the east side of the Juniata passed through a four-inch seam of *coal* at 14 feet from the surface. This is at approximately 200 feet from the top of the group. Part of the *coal*, thrown out while the writer was present, was good, but most of it appeared to be slaty.

No distinct *coal bed* was observed on the Juniata below Riddlesburg in the upper part of the group; nor is there any in the same division as exposed by the railroad cut on Yellow creek opposite Hopewell. But, in that cut at 445 feet from the bottom of the great sandstone, is a mass of contorted conglomerate, about 30 feet thick, which contains strings of *coal* and irregular pockets of very carbonaceous shale. A *coal bed* occurs in this position at half a mile south from Yellow creek and varies from 2 to 4 inches. No. 3 of the Yellow creek section contains abundance of plant stems, coated with films of *coal*. Strings of *coal*, very brilliant, are by no means rare and some layers of the rock are crowded with comminuted fragments of carbonized wood. The "anthracite" *coal* of Town hill just beyond the State line in Maryland evidently belongs here.

The *coal* deposits in the Pocono hardly deserve to be called beds. They are irregular in structure and of very limited extent. Thus at the gap made by the Juniata through Allequippa mountain no trace of a *coal bed* is seen in the sandstone, yet three streaks were found at Riddlesburg. Similarly no trace of a *coal bed* is shown on the west side of the Juniata in the upper 200 feet, or in any other part of the great sandstone, yet a bunch of *coal* 4 inches thick occurs at Hopewell on the opposite side of the river. The same condition is seen in the lower sandstone of the Yellow creek section. These strings and bunches of *coal* possess much interest as they show that conditions favorable to the formation of coal were well advanced in Pennsylvania in the Pocono age.

The geological line between the Pocono and the Mauch Chunk formations is distinct in north-east Bedford county; but on Wills creek in the south-west part of the county the Pocono sandstone passes gradually upwards into a bed which the writer, in his reports on Fayette and Westmoreland counties, called *the silicious limestone*. This bed is much more closely related to the Pocono sandstone than to the Mauch Chunk shales, so that in all probability it should be placed with the former.

The variations shown by the Pocono in going westward are of some interest. In Sideling hill Mr. Ashburner finds its thickness to be 2133 feet; on the Juniata it is less than 1400 feet; on Wills creek it is not more than 930 feet; while in Fayette county under Chestnut ridge it is not more than 400 feet.

The change is greater within the district than that shown by the Mauch Chunk, though both groups have approximately the same thickness under Chestnut ridge in Fayette county.

CHAPTER IV.

The Devonian system.

The Devonian is represented within the Bedford and Fulton district by the Catskill, the Chemung, and the Hamilton groups.

The Catskill red sandstone, No. IX.

This group is exposed within Bedford county along the east face of the Allegheny mountain, and in the Savage Mountain basin; it occupies an extensive area north from the Bedford and Chambersburg pike beyond Warrior ridge whence prongs extend southward in the several synclinals; in Fulton county it is the surface rock of Whip cove; a broad strip follows the east side of Sideling hill widening northward; while an oval belt surrounds the Pocono of Scrub Ridge and Meadow Ground mountain.

The Catskill is a mass of shale and sandstone with no definite succession of beds. A section obtained at one locality would be of little service four or five miles away, as the sandstones and shales replace each other suddenly.

The group shows very marked decrease in thickness as it goes westward. On the Bedford and Chambersburg pike in Fulton county, between Patterson's run and the Pocono of Scrub ridge, the exposures show 3900 feet of Catskill; on Yellow creek in Hopewell township of Bedford county the thickness is not far from 3000 feet; while on Wills creek in south-west Bedford it is 1980 feet. No measurements of the group are available in Somerset county; but at the west side of that county, under the eastern slope of Laurel Hill, some thinly flaggy, brownish and somewhat micaceous sandstone was seen, which probably belongs to

this group; this, however, is absent from the west slope of that anticlinal, and not a trace of the Catskill remains in Fayette or Westmoreland county under the Chestnut Ridge anticlinal. In crossing Somerset and Cambria county, therefore, the group thins out from 1980 feet to zero, a much greater decrease than is shown by either the Mauch Chunk or Pocono.

As already stated, the composition of this group is extremely variable. On the east side of Sideling hill towards the middle of Fulton county, it contains only soft red shales with occasional flags of sandstone for 1600 feet from the top. Below that are brownish or greenish-red sandstones extending to within say 250 feet of the assumed base of the group. Then come red shales alternating with yellow shales.

A similar condition appears to prevail along the Chambersburg pike in Bedford county between Ray's hills and the river, but the sandstones of the lower portion are more nearly thick bedded and show less approach to lamination than in Fulton county. But on the Juniata river, in the northern part of West Providence township, where the stream makes two long curves, the whole mass seems to be equally divided throughout into shales and sandstones.

On the Huntingdon and Broad Top railroad a fair exposure of the upper part of the group was found. As shown there, it consists largely of blood red shales and argillaceous sandstone, the latter often handsomely ripple-marked. The lower part of the group is reached at Saxton but there it is concealed. The upper part is wholly concealed on Yellow creek; but, at 870 feet below the last exposure of Pocono, a good exposure begins, showing 400 feet of sandstone, compact, and reddish-brown, becoming very dingy when weathered. Below this are 717 feet of shales and sandstones, very fairly exposed; the shales deep red, the sandstones brownish-red and in very thin flags, rarely more than half an inch thick. Everywhere, the Catskill sandstones are cross-bedded, and many of them on weathering have a strangely pitted surface, as though irregular worm borings had been made, in groups, to a depth of from one half to one eighth of an inch. The limits of the formation are ill-de-

fined on Yellow creek, neither the top nor the bottom being shown.

Along Wills creek the exposure is almost complete. Thinly flaggy sandstones predominate in the upper part, but shales predominate lower down, where such sandstones as are present are soft and argillaceous. For the most part, the shales are brilliant red with some white spots, but here and there are some gray beds, mostly very thin.

Along the side of the Allegheny Mountain the Catskill forms a handsome terrace, but exposures are indefinite. The red, thinly flaggy sandstone seems to be present in greater or less quantity throughout.

No fossils were observed in this group except on Wills creek, where *Modiola angusta* was obtained from one of the highest beds. No traces of fish remains were found.

Chemung shales and Portage flags.

(*Upper division of No. VIII.*)

Few attempts have been made in the description of Bedford county to divide this group into Chemung and Portage. Further north the separation appears to be made easily, and it can be made without difficulty in Fulton county using purely lithological characters as a basis. But in Bedford county, as will appear from the sections to be given, there is no satisfactory means of making any such division, and so for the most part *the whole has been called Chemung* in the body of the report.

No detailed exposure of any but the Portage was obtained in Fulton county; but the general subdivisions are distinct. The following may be taken as a generalized section for Fulton county:

1. Shales with occasional beds of sandstone,	800'
2. Sandstone, with layers of <i>conglomerate</i> ,	10'
3. Shales and sandstones,	950'
4. Sandstone with <i>conglomerate</i> layers,	10'±
5. Shales,	450'
6. Portage flags,	1400'
	<hr/>
	3620'

The undoubted Chemung embraces Nos. 1 to 5 inclusive.

Alternating beds of red and yellow shales occur in No. 1, with here and there a thin bed of sandstone. *Spirifera disjuncta* occurs at the top of the section. Between 200 and 300 feet of similar red and yellow shales are not placed in this section as they contain no fossils, so far as examined. Lithologically, however, they belong here and not with the Catskill, for there is no reason in behalf of drawing a line within this mass, aside from the fact that the writer found no fossils at any horizon higher than that given. Doubtless the best plan would be to carry Chemung to the top of the shales and to let the Catskill begin with the first appearance of the red, almost laminated sandstones with the worm-eaten surface. This is a well marked lithological change, affording a good line of separation.

The *conglomerates* Nos. 2 and 4 are designated in the body of this report merely as the Upper and the Lower. Within Fulton county, they are ordinarily thin, but as their fragments resist the weather admirably and a large amount of débris marks the lines of their outcrops, one might think them beds of imposing thickness. They are distinctly ridge-makers, and their ridges are sometimes of imposing height. Clear ridge of Taylor and Dublin townships is caused by the upper conglomerate. It is continuous from the Huntingdon county line southward into Licking Creek township, where, crossing the pike east from Siluvia, it becomes Black Oak ridge, which is continuous thence into Maryland. In Thompson and Belfast townships the conglomerates make the crests of Timber Ridge. These are all marked topographical features. The conglomerates vary much in coarseness, sometimes showing only small pebbles, while at other times the pebbles have a longer diameter of 2 inches. The larger pebbles are flat. Occasionally the whole bed is conglomerate.

Interval No. 3 between the conglomerates is poorly exposed. It contains much yellow shale, some very hard red sandstone streaked with white quartz, and at many places bright red shale, with brown flaggy sandstone very similar to that of the Catskill.

Interval No. 5 is thin on the Bedford and Chambersburg

pike but it increases southward to the east side of the Foster run valley, where it is fairly well exposed. It holds variegated shales, blue, gray, olive and black in the upper portion, but almost wholly yellow in the lower portion.

The passage into No. 6 is gradual but sufficiently distinct.

The flags, No. 6, are well shown on the Bedford pike east from Licking creek; they form the sides of Timber Ridge, and are well shown on Tonoloway creek at and below Franklin mills in Bethel township. On surface of fresh fracture they are generally olive or grayish-olive, but the weathered surface is dingy, covered with a grayish lichen, so that the whole bears a marked resemblance to the Catskill. Shale is present in comparatively small quantity, and such as is present seems to resist the weather almost as well as the flags do. At many places this series forms bold cliffs. Some of the layers contain fossils, which are *distinctly Chemung*, none whatever of Portage type being present. But owing to the weathering, the forms can be identified only generically.

In Bedford county, a very good section to illustrate the succession of the beds was obtained on the Huntingdon and Broad Top railroad, beginning in Saxton and continuing thence north-eastward. Condensed it is as follows:

1. Red to yellow shales with thin sandstones,	418'	
2. <i>Upper conglomerate</i> ,	10'	
3. Shale,	30'	
4. Sandstone,	12'	
5. Shale and sandstone,	30'	
6. Concealed, estimated,	450'	
7. Shales and flaggy sandstones,	101'	
8. Sandstones and thin shales,	76'	
9. Shales with flags of sandstone,	30'	
10. Sandstone,	16'	
11. Shale, ill-exposed,	185'	
12. Sandstone,	35'	
13. Shales,	40'	
14. <i>Lower conglomerate</i> ,	8'	
15. Shales with flaggy sandstones,	115'	
16. Concealed, estimated,	310'	
17. Flags and shales,	500'	} =1100' ±
18. Sandstone,	211'	
19. Variegated shale,	1047'	
20. Concealed,	118'	
21. Shale with irregular flaggy sandstone,	165'	
22. Shales and flags,	203'	

The measurements are given as made along the road, but those below and including No. 17 are defective, in that they were taken off the dip. The reduction necessary is somewhat more than one half, so that the thickness of this part of the section is not far from 1100 feet, including therein a part of the concealed interval between the last member of the section and the first exposure of Hamilton beyond. On Yellow creek, the thickness including much of No. 16 is 1360 feet. So that the total thickness of Chemung as here exposed is almost 3000 feet; but the top of the group is concealed at Saxton, so that something will have to be added; if the top shales are as thick as in Fulton county the thickness of Chemung is almost 3400 feet.

The upper part of the section could not be found in Bedford county.

The beds above the upper conglomerate are shown in Saxton, where they are more or less fossiliferous throughout. *Streptorhynchus chemungensis* and an *Orthis* closely allied to *O. Tioga* occur in the highest bed along with *Spirifera disjuncta*. Slabs of sandstones occur in this interval along the east foot of the Allegheny mountain which show great numbers of characteristic Chemung lamelli-branches. This part of the group shows few variations except in thickness and it is fairly well shown southward along the east side of Addison ridge; at several place in the southern part of West Providence; and very well in the long strip of Chemung in Union, West St. Clair and Napier townships.

The *upper conglomerate* is emphatically a ridge maker. It is the back-bone of Addison ridge from Brush creek southward to beyond the Maryland line; and of Clear ridge from the northern edge of West Providence to the same line. Its outcrops in the synclinals form Hoop-Pole, Raccoon, Snyder's, and Ward's ridges in Monroe and Southampton, and in the latter township it forms the bold Huff's knob. In the western part of the county its outcrop on the west side of the Savage Mountain anticlinal is marked by a noble ridge, entering the county at the north from Blair in Blue knob, and extending thence to where it passes into Somerset county north from the Juniata river; while its

curved outcrop in the Savage Mountain basin is marked by a bold ridge of which Dry ridge in Juniata township is the northern termination. Much of the ruggedness characterizing the region west from Wills and Dunning mountains is due to this rock. At Saxton the thickness is insignificant but the rock is very hard. It is bluish-gray, with films of quartz in the joints, and contains rounded pebbles of white quartz, some of them flattened. This rock becomes much thicker southward on Addison ridge, where it is ferruginous in some of the upper layers. No exposures of the rock in place occur on any of the ridges between Addison and Clear ridges, but its position is marked distinctly by loose fragments.

The upper conglomerate is rarely exposed in place within the western area, as the jointing renders it readily susceptible to atmospheric action; but the rock is very hard, and the talus is large, so that the position is always unmistakable. This bed contains indistinct fossils at Saxton, and some layers are rich in fossils on Addison ridge.

The *lower conglomerate* appears to be insignificant at most localities within Bedford county, and it was recognized only at Saxton, on Raccoon ridge in Monroe township, on the Dry Ridge pike in Juniata, on the Pittsburgh pike in Napier; while fragments of it were also found in Londonderry on the ridge facing Little Mills creek, and in Union township on Scrub-Grass run north from Mowry's mills. It is embedded in shales, which vary in color from brown to yellow. No fossils were seen close to the conglomerate, but near the bottom of No. 15 a layer was found which contains *Ambocalia*, *Rhynchonella*, *Productus* and *Streptorhynchus*.

No. 16 is wholly concealed north from Saxton and much of it is concealed on Yellow creek. It is fairly well exposed on the Dry ridge and Pittsburgh pikes, where it consists mostly of shale but contains some olive-colored flags. Some fossils were seen here, but they are in loose fragments and in all likelihood come from No. 15.

Much yellow shale occurs in the interval, No. 16. Partial exposures were seen frequently in Monroe and South-

ampton townships on Hoop-Pole and Raccoon ridges, where some of the beds are fossiliferous. The same shales were seen in many places in the western area, but in all cases the exposures are very fragmentary and afford no details. At Saxton the Juniata flows in this interval and on Yellow creek everything is concealed.

The division between Chemung and Portage would be made at the base of No. 16 by one working westward from Fulton county; for, in No. 17, the olive flags and shales are reached, while in No. 18 little shale is present in north-western Bedford. This whole mass is non-fossiliferous in the Saxton section, at least no fossils were seen; but on Yellow creek fossils occur at several horizons. A thin, coarse ferruginous limestone, 4 inches, near the top contains *Spirifera disjuncta* with crinoid stems and some forms too indistinct for identification. At a little way lower is a layer crowded with an *Aviculopecten*; while midway is a layer with *Spirifera disjuncta*. The sandstone equivalent to No. 18 contains *Spirifera disjuncta* at 90 feet from the bottom. Some layers of this dark sandstone are very fossiliferous on the Pittsburgh pike; for at one locality *Atrypa aspera*, *Atrypa reticularis*, *Streptorhynchus chemungensis*, *Ambocelia gregaria* and *Sanguinolites* sp. were found. Fucoids occur in this sandstone, but they are not numerous. These beds are very fossiliferous on a road leading northward from West End post-office on the Dry Ridge pike.

No. 19 is a mass of variegated shale, fairly well exposed on the Huntingdon railroad and on the Pittsburgh pike, but it is almost wholly concealed on Yellow creek and the exposures are very poor elsewhere. In the upper part it contains *Spirifera disjuncta*, *Leiorhynchus quadricostatus* and crinoid stems; while lower down it has *Rhynchonella* and *Spirifera*, both too obscure for specific determination. Flags predominate in the upper part along the Pittsburgh pike, but they become scanty below.

From No. 19 to the base of the section are flags and shales, mostly olive, in which no fossils were observed.

It will be seen by reference to the detailed section that,

while Nos. 17 and 18 bear some resemblance to the great mass of flags observed in Fulton county, yet the section is very different. In Fulton county flags so predominate as to give the impression at first glance that sandstone alone is present. But in Bedford county sandstone is not the predominant rock. In Fulton county Chemung fossils occur at only few horizons in the flags, whereas in Bedford county they are found at many horizons down to within less than 300 feet of the bottom.

No Portage fossils were found at any locality.

This whole series shows a noteworthy decrease in thickness westward; for on Wills creek, where no exposures occur, the interval occupied by the Chemung and Hamilton is not far from 2630 feet. In Fayette county under Chestnut Ridge (on both the Youghiogheny and the Conemaugh) the red and yellow shales of No. 1 with the upper conglomerate and much of the interval between the conglomerates has disappeared, so that there the Pocono rests on shales at little more than 400 feet above the lower conglomerate.

Genesee, Hamilton, and Marcellus shales

(Lower division of No. VIII.)

The Hamilton group as a whole shows within this district the threefold division recognized and named in New York as Genesee shale, Hamilton shale, and Marcellus shale; but owing to the varying thickness of these subdivisions and to the fact that the soft shales yield readily to the weather, one finds much difficulty in identifying them. Especial annoyance is caused by the Genesee shales, which are rarely exposed.

The Hamilton group occupies narrow strips along the sides of the anticlinals. A rudely oval belt surrounds the Mount Savage anticlinal in Chestnut Ridge; strips are exposed on the west side of Wills and Dunnings mountains; in the Bedford synclinal; and along the east foot of Warrior Ridge. Thence eastward the group is not brought up again until the Pigeon Cove anticlinal is reached, where the lower part of the group is shown. The group is brought up again

further east by the Blacklog and Cove anticlinals and is exposed in Thompson, Ayr, and Dublin townships of Fulton county.

North-east from Saxton, a section was obtained which, condensed, is as follows :

1. Genesee shale,	200'±
2. Hamilton shale,	798'
3. Marcellus shale,	794'

The Genesee shale was seen on Tonoloway creek near the northern edge of Thompson township and on the west side of Tonoloway ridge in Bethel township, but it is concealed elsewhere in Fulton county. In Bedford county it is well shown on the Pittsburgh pike at and west from R. Colvin's house in Napier township, and a fair exposure was found in the southern part of the same township near C. Wetstone's house. Elsewhere the exposures are very indefinite.

The thickness on the Pittsburgh pike is not far from 420', but it is certainly much less in the section obtained north-east from Saxton, where the whole concealed interval from the last Chemung exposure to the Hamilton shales is only 237 feet. The thickness is certainly little more than 150 feet on the sides of the Pigeon Cove anticlinal in Fulton county. For the most part, the rock is dark shale, but it contains not a little of brown shale with olive colored flags.

The *Hamilton shales* are rather laminated sandstones, which vary much in hardness. The softer argillaceous shales are not persistent and the harder beds ordinarily make a well-defined ridge, which is almost as high as that of the lower Chemung beds. These shaly or laminated sandstones are very hard on the east side of the Pigeon Cove anticlinal, where they resist the weather almost as well as the Portage flags do. They are imperfectly exposed along the side of the anticlinal of McConnell's cove, where they appear to be thin.

These shales are often exposed in Bedford county, where the group shows comparatively little variation. The argillaceous shales seldom contain fossils, but the sandy shales or laminated sandstones are usually fossiliferous. *Tropidoleptus carinatus*, *Spirifera mucronata*, *Leiorhynchus*

sp., and *Streptorhynchus chemungensis*, var. prevail throughout; while species of *Bellerophon* and *Pleurotomaria* are abundant in the highest beds. A fine *Spirophyton* occurs at several horizons.

The presence of the *Marcellus* is shown at all localities where the sub-group is present, but an exposure affording details for measurement is rare. The only satisfactory exposure is that north-east from Saxton where the succession is:

<i>Marcellus</i> ,	1. Shales drab to gray, weathering dirty white,	231'
	2. Concealed,	103'
	3. Shales fissile, dark to black,	308'
	4. Shale and limestone,	68'
	5. Concealed down to the Oriskany, (black shales and limestones,)	84'

Exposures elsewhere show that the black shales with limestone extend to the Oriskany.

Both division of the group are persistent. Iron ore occurs at the bottom of the drab shales in Dublin and Ayr townships of Fulton county.

The shales of the lower division increase in blackness toward the base, and many of the beds are *wrinkled* like gneiss, a characteristic of the *Marcellus* over a great area. Digging for coal has been done at several localities in both counties, and coal-rights are said to have been sold more than once for very fair prices. Iron ore occurs along Warrior ridge at the bottom of the *Marcellus*. A very good section of No. 4 was obtained northeast from Saxton, which is as follows:

Saxton section of Marcellus beds.

1. Shales black, wrinkled like gneiss or micaceous shale, breaking like rotten wood,	12'
2. Limestone, blue,	0' 5"
3. Shale, like No. 1,	0' 2"
4. Limestone,	0' 3"
5. Shale,	0' 6"
6. Limestone,	0' 3"
7. Shale,	1' 0"
8. Limestone,	0' 2"
9. Shale, wrinkled like No. 1,	3' 0"
10. Limestone,	0' 3"
11. Shale, wrinkled like No. 1,	1' 0"

12. Limestone, upper surface wrinkled,	0' 3"
13. Shale,	5' 0"
14. Limestone,	0' 5"
15. Shale,	4' 0"
16. Limestone,	0' 4"
17. Shale,	12' 0"
18. Limestone,	0' 6"
19. Shale,	1' 3"
20. Limestone,	1' 0"
21. Shale,	10' 0"
22. Limestone,	0' 5"
23. Shale,	7' 0"
24. Limestone,	0' 4"
25. Shale,	8' 0"
	<hr/>
	68' 5"

Below this the limestone is less in quantity. It is present at all localities. The only fossil seen is a broad winged *pterinea* of Hamilton affinities. It could not be taken from the rock.

CHAPTER V.

The Silurian System.

The Upper Silurian.

The Upper Silurian* is represented within the district by the Oriskany, the Lower Helderberg, the Clinton and the Medina ; the Oneida being absent.

Oriskany sandstone, No. VII.

The Oriskany is usually regarded as a ridge-making group, but much of this credit given to it belongs really to the Lower Helderberg limestones, which resist the weather better for the most part within Bedford and Fulton counties than the Oriskany sandstone does.

The Oriskany is exposed in Fulton county on both sides of the Black Log anticlinal, where its ridges are high ; on the west side of Dickey's mountain, where the ridge is indistinct ; and on both sides of the Pigeon Cove anticlinal, where its ridges are prominent. In Bedford county it forms the east slope of Warrior ridge from the Maryland line northward into Huntingdon county ; it is shown on Knobbly mountain in the Bedford synclinal : it follows the west foot of Wills and Dunning mountains from the Maryland line into King township ; and it is brought up with oval outcrop by the Savage Mountain anticlinal in Napier and St. Clair townships.

Throughout, it is a sandstone, though occasionally it contains not a little calcareous matter.

Much of the group in the greater part of the district yields readily to the weather, so that good exposures are

* Of the British survey ; the Silurian of Sedgwick and others.

rare. This is especially the case in the northern part of Bedford county, where Warrior ridge is so worn by erosion as to be hardly traceable. There the thickness seems to be little more than 90 feet. The rock is harder in northern Fulton where, however, the group is certainly thinner. The rock becomes harder southward, as shown by the greater height of the ridges. A very good exposure was found on Wills creek near Hyndman, where the following section was obtained :

Hyndman section of Oriskany beds.

1. Gray sandstone, somewhat pebbly, soft, not fully shown, .	40'
2. Bluish grit with fossils,	6'
3. Grit, very hard, blue to gray, some layers pebbly; fossils numerous throughout,	30'
4. Sandstone, fine-grained, gray fossiliferous,	8'
5. Hard grit, weathers jaspery,	10'
6. Blue grit,	10'
7. Sandstone, fine-grained, dark blue, richly fossiliferous, .	34'
8. Calcareous sandstone or silicious limestone,	20'
	158'

A noteworthy feature here is the presence of much calcareous matter in several of the beds, a condition which is very marked at Cumberland. On the west slope of Dickey's mountain in Ayr township of Fulton county, some beds of this group contain so much calcareous matter that they have been burned into lime which answers very well for building purposes, though it is not thought profitable for agricultural uses. The beds above No. 8 yield the following fossils: *Spirifera arenosa*, *S. arrecta*, *S. Cumberlandia*, *Merista lata*, *Rensselaeria ovalis*, *R. Suessana*, *Eatonina singularis*, *Strophodonta magnifica*, *Streptorhynchus hipparionyx*, *Megambonia*, *Platyceras* and *Platyostoma*. A furoid occurs in No. 7.

No. 7 passes very gradually into No. 8, which is the bed of transition to the Lower Helderberg. This is exceedingly cherty and its whitened fragments occur abundantly on every Oriskany ridge in Bedford county. It contains *Spirifera arenosa*, *Platyceras*, and abundance of *Favosites Helderbergia*. This bed is persistent southward.

Lower Helderberg limestone, No. VI.

This group has much the same general distribution as the Oriskany, but its belts are wider. It is a ridge-making group.

The Lower Helderberg is triple within this district the subdivision being as follows:

On the Maryland state line.

VI. c. Limestones, mostly massive, (Lewistown limestone,)	336'
VI. b. Limestones, flaggy, cement beds,	283'
VI. a. Shales and thin irregular limestones,	628'
	<hr/>
	1247'
	<hr/>

These measurements were obtained near the Maryland line in Bedford county.

On the Bedford and Chambersburg pike going eastward from the foot of Tussey mountain the total thickness, as calculated, is 1320'.

The following section of No. VI. c. was obtained on the Baltimore and Ohio railroad near Hyndman:

Hyndman section of No. VI. c.

1. Dark blue fall flaggy limestone,	40'
2. Shaly limestone,	20'
3. Flaggy limestone,	25'
4. Gray massive limestone,	20'
5. Dark blue limestone,	22'
6. Gray limestone,	12'
7. Blue irregularly-bedded limestone,	37'
8. Flaggy limestone,	25'
9. Gray and blue limestone,	40'
10. Flaggy limestone,	25'
11. Gray limestone,	45'
12. Cherty limestone,	25'
	<hr/>
	326'
	<hr/>

No. 1 underlies the *silicious limestone* or transition bed, which has been referred to the Oriskany.

The gray limestones are semi-crystalline and yield lime of decided excellence. They are quarried at many localities in both Bedford and Fulton, supplying the flux for the furnaces, and lime for farming and building purposes.

Nos. 4, 5, and 7 are fossiliferous at Hyndman; but, except in No. 7, the forms are indistinct, as they have not been silicified, so that the weathered surface shows only their sections. *Stromatopora* occurs plentifully everywhere at the place of No. 7. The fossils are more distinct further north. *Caninia*, *Favosites*, *Orthis*, *Rhynchonella ventricosa*, and *Pentamerus pseudogaleatus* were found in the higher layers, while lower down occur forms characterizing the *Deltathyris Shaly Limestone* group at Schoharie, New York.

It is sufficiently clear from the distribution of the fossils that this *upper division* VI. c. represents the massive limestone of New York. Patient collecting of fossils in the vicinity of Bedford Springs would no doubt yield material for close identification of the New York sub-divisions.

This portion of the group is fairly well shown at many places along the west foot of Will's Mountain. It is the main body of Knobbly mountain in the Bedford synclinal, where partial exposures were seen frequently; it is exposed to a greater or less extent in every gap through Warrior ridge; fair exposures are shown in the vicinity of Fort Littleton and on Cove creek in Fulton county. The features are the same everywhere within the district.

Iron ore occurs in this sub-division. Reference to it will be made in the chapters on the iron interests.

The *middle division* VI. b. represents the *Tentaculite limestone* of New York, which is perhaps the upper division of the *Waterlime*. It is nowhere exposed in detail, but it consists mainly of blue to very dark blue flaggy to slaty limestones, most by non-fossiliferous. The darker limestones are fetid when struck and ring sharply. Some reddish beds near the middle of the mass are not flaggy but thick-bedded. Partial exposures of this division were seen at Hyndman and elsewhere along the west foot of Will's mountain; a very fair exposure was found in Cumberland Valley township of Bedford county, where the thickness as given was measured. An imperfect exposure was seen on the Bedford and Chambersburg pike west from Everett, and another, further north, on Piper's run. No good exposure was found in Fulton county. *Leperditia alta* and *Holopæa antiqua* were seen on

Piper's run; *Beyrichia*, *Spirorbis*, *Leperditia alta*, *Spirifera vanuxemi*, and *Megambonia aviculoidea* were seen in Bedford borough. All of these forms are characteristic of the *Tentaculite limestone*.

The *lower division* VI. c. consists of drab to reddish calcareous shales with thin streaks of limestone. The Cumberland road south from Bedford lies for most of the distance on this division. Imperfect exposures were seen on the Bedford and Chambersburg pike in Black valley, as well as at many localities further south in that valley. This division is fairly well shown in Fulton county near Fort Littleton, and it is the immediately underlying rock of Pigeon Cove in that county. Toward the bottom it contains an irregular and impure limestone, which is quarried for agricultural uses at some localities. The only fossil seen is *Leperditia*.

Salina and Niagara beds.

These are not separated from the Clinton in the body of this report, for they are generally regarded as belonging to that group by those concerned in the economic interests of the district. Nor is the separation as made here to be looked on as anything more than a mere suggestion.

No detailed section of the portion thus set off from the Clinton was obtained. Its thickness as shown in the Kemble Company's tunnel near Tatesville is 275 feet, of which considerably more than one half may be regarded as belonging to the Salina. This upper part forms the well-marked red ridge which is distinct along Black Valley; on the west side of the Bedford synclinal and in Bean's cove; is fairly well shown along the west foot of Wills mountain; but is not distinct in Fulton county as a topographical feature. The highest rock is a red sandstone, fine-grained, and grit-like, which shows films of quartz honeycombing the mass. This rock, which is from 15 to 20 feet thick, forms the Red or Rocky ridge of Bedford county. Underlying this are alternations of red and yellow shales, which are fairly well exposed at many places in north Bedford and Fulton counties. The top rock is wanting in Fulton county but the red shales are as distinct there as in Bedford. These

beds, in all about 150 feet thick, are referred provisionally to the Salina group of New York. No fossils occur in them nor do they appear to be salt-bearing.

The remainder of the Red Ridge rocks is referred provisionally to the Niagara. These consist of thin layers of limestone separated by variegated shales making a very gradual passage from the red shales and marls to the Clinton shales below. The limestones rarely exceed six inches in thickness and fossils were seen only in the highest bed, which at many places is crowded with *Trematospira*.

Clinton red shale, No. V.

This is the best concealed group in the whole district, no satisfactory exposures of it having been found. It occurs along both sides of Wills mountain; on the west side of Evitts mountain; on the east side of Tussey mountain; surrounds the termination of the Black Log anticlinal in Fulton county and is shown on both sides of the Cove anticlinal; but Medina débris effectually conceals its details at almost all localities. The general section of the group is

<i>Clinton No. V,</i> {	1. Shales, red and yellow,	197'	
	2. <i>Fossil ore bed</i> ,	1'	to 10'
	3. Shales, green, yellow and purple,	385'	
	4. " <i>Frankstown</i> " ore bed,	0'	10''
	5. Shales, green and yellow,	288'	
	6. " <i>Block</i> " ore bed,	2'	
	7. Interval to Medina,	10' ?	
		888'	

Thus making the whole interval from the top of the Red ridge down to the Medina (Formation No. V of the First Survey) about 1150 feet.

The shales, No. 1, are rich in fossils at many horizons and show such a mingling of Clinton and Niagara forms as to render extremely questionable the propriety of drawing a line between Clinton and Niagara anywhere *above the fossil ore bed*.

The upper ore bed is the one mined in Black valley; along the west side of Wills mountain and at Dutch Corner; it has been opened at many places in the Bedford synclinal along both Evitts and Wills mountains. It is

barely 14 inches thick in Londonderry township, but breaks up into several layers separated by shale; this condition prevails in the Bedford synclinal at many places. It is always double in Black valley, where it sometimes attains to great thickness.

The "Frankstown" ore bed has been exposed on the side of Dunning's mountain and at places in the Bedford basin.

The "Block" ore bed seems persistent as a brown hematite, but the only information respecting its thickness is derived from an opening made since the examination of the county was concluded. Further details respecting the fossil ore beds will be found in the chapter on the iron interests of the district.

Medina and Oneida sandstone, No. IV.

The Medina is a bold mountain-maker, forming Wills, Dunning, Evitts, Tussey, Black Log, Shade, Cove, and Tuscarora mountains. The Medina is double.

No. IV. c. Upper or white Medina, 200' to 860'

No. IV. b. Lower or red Medina, 600' ? to 1200'

No detailed exposures were found in Fulton county, but the thickness of the whole series on Cove mountain was found to be very nearly 1600'. The Upper Medina forms the crest and body of the mountains, while the Lower Medina forms the "terrace," which is so distinct in all the coves.

The Upper Medina is a fine-grained, grit-like rock, very hard and usually almost snow-white. The maximum thickness observed in Bedford county was in Tussey mountain at the gap of Yellow creek. It *decreases southward*, for, at the Juniata gap through the same mountain, the thickness is not more than 300 feet, while in the gap through Evitts mountain it cannot be much more than 200 feet. No detailed exposures were found in any of the gaps through Buffalo mountain, but the rock seems to be somewhat thicker there than in the Juniata gap through Evitts mountain. No fossils aside from the characteristic *Arthropycus harlani* were seen at any exposure.

The Lower Medina evidently *diminishes in thickness southward* from Yellow Creek gap to the Juniata, but de-

tails are still wanting for determination of the rate of decrease. The maximum thickness was obtained in Yellow Creek gap. The conditions are complicated on the Juniata by the presence of anticlinals, which are described in the chapter on the region between Evitts and Tussey mountains. The rock is red, hard, fine-grained and shows comparatively little shale. The grit contains specks of ferruginous clay, which drop out on exposure to the weather so as to give the rock a pitted surface. Flattened lumps of red clay are present in many of the beds.

No. IV. a.—No Oneida rocks were recognized south from Morrison's cove. A gray sandstone is shown in Raver's Creek gap through Tussey; and in Woodberry township, where the Henrietta road leaves that leading to Raver's Creek gap. It is shown imperfectly in Dunning's mountain, having been seen near D. Barley's tannery and on the road leading past J. Long's house; but it was not seen on the road leading over the mountain to St. Clairsville.

Oneida is certainly absent along the Juniata in Tussey and Evitts; for the passage from Lower Medina to Hudson is imperceptible, and the red or brownish red shales yield *Ambonychia radiata* and *Rhynchonella capax*. The total thickness of the Oneida sandstone is not more than 35 feet, where seen within this district. Its place is wholly concealed in Fulton county.

The Lower Silurian system.

The Lower Silurian* is represented by the Hudson, Utica, Trenton, and Calciferos, the Potsdam being concealed.

Hudson and Utica slates, No. III.

These groups are exposed on the sides of Milligan's, Friend's, and Morrison's coves in Bedford county and on the sides of McConnell's cove in Fulton. The Hudson is usually involved to some extent in the "terrace" of Lower Medina, and the upper part of the group is rarely shown.

*Of the British survey; the Cambrian of Sedgwick; the Siluro-Cambrian of Sterry-Hunt and others.

The horizontal space occupied by both groups along the Juniata, west from Tussey mountain, is 1040', the dip varying from 30 to 60 degrees, which would indicate a total thickness of not far from 700 feet for the whole series. A similar thickness was found on the west side of Friend's cove near Evitts mountain. In McConnell's cove, the exposure is very indefinite but the thickness is certainly greater than at the Bedford localities.

The Hudson beds near the top contain some sandstones, but these are thin and the great body of the group consists of yellow shale. This passes gradually into brown shale, which in its turn passes almost imperceptibly into the black shales of the Utica.

The Utica shales, underneath, which are not far from 200 feet thick in Friend's Cove, are shown on the Bedford pike near Willow Grove, where they contain some layers of compact slate more than an inch thick. Fragmentary exposures occur in Morrison's cove along Dunnings mountain and in McConnell's cove along the foot of Tuscarora mountain as well as on Licking creek.

A few graptolites were seen in the shale. The Yellow shales of the Hudson are apparently non-fossiliferous, but the sandstones contain forms characteristic of the group.

Trenton and Calcififerous limestones, No. II.

This great limestone group is the immediately underlying series in the greater part of McConnell's, Friend's and Morrison's coves, and its highest beds are shown in Milligan's cove. The line of separation from the overlying Utica shale is almost abrupt. A section was obtained on the Bedford division of the Pennsylvania railroad in Snake Spring township of Bedford county, as follows :

- | | |
|--|------|
| 1. Limestone, | 420' |
| <p>Ill-shown on the railroad, but exposed on Bedford pike and between the pike and the river, as well as south from the river. It is shown also in Morrison's cove along the east foot of Dunnings mountain. Near the top it consists of blue flaggy limestone, but lower down the beds become thicker and the color becomes light blue to gray. For the most part the rock is not silicious and many of the beds yield lime of superior excellence.</p> | |

2. Limestone, 1351'

The highest beds are comparatively free from silicious matter, but lumps of white chert make their appearance above the middle, or at nearly 600 feet from the top. Thence for about 400 feet, the rock is a cherty limestone; but below that it becomes more and more silicious. Black chert appears at about 1200 feet from the top and the streaks of chert are so numerous that the rock weathers with fretted surface.

3. Concealed, 419'

4. Limestone; mostly silicious, 419'

5. Concealed, estimated at 400'

6. Limestone, exposures imperfect; rock silicious, . . . 175'

7. Concealed, 150'

8. Limestone, 300'

This is a cherty calcareous grit, with so much chert that it weathers with fretted surface.

9. Concealed, 90'

10. Limestone, 620'

This is a sandy limestone and contains very little chert; much of it might be termed merely a calcareous sandstone.

11. Concealed, 175'

Total exhibited in this section, 4519'

It is altogether probable that toward the northern edge of Bedford county a greater thickness of the rock is brought up; but no details were obtained there.

Fossils appear to be rare. *Calymene senaria* and *Strophomena alternata* were obtained from one of the highest beds of No. 1; and *Columnaria alveolata* was seen in Morrison's cove. Cyathophylloid corals were seen near the base of No. 2 along the Juniata.

The iron ores of this group will be described in the chapter devoted to the iron interests.

CHAPTER VI.

The region between Wills-Dunning mountain and the Somerset county line.

This area includes Londonderry, Harrison, Juniata, Napier, East and West St Clair, King, and Union townships, with a part of Bedford. Wills Mountain is the eastern boundary from the State line to midway in Bedford township; there the mountain ends, but within 5 miles Dunning's mountain rises and thence is the eastern boundary to beyond the Blair county line. The Savage Mountain synclinal, the Savage Mountain, Pine Ridge and Hyndman anticlinals fall within this area. The column exposed here reaches from the Trenton limestone to the Pottsville conglomerate.

The lowest (Trenton) rocks are exposed only within the park known as Milligan's cove, which has been eroded along the line of Wills mountain in Harrison township. Rocks of the Upper Silurian are shown along the west slope of Wills mountain and are brought up again further west by the Savage Mountain anticlinal in Napier and St. Clair townships as well as by Pine Ridge in King township. Elsewhere the rocks are Devonian, except on top of the Allegheny mountain and Savage mountain, where rocks of the Carboniferous system are exposed.

Geology along the county road on Wills creek.

At the State line the road lies in the "bottom" of Wills creek which has been eroded in the Oriskany and Hamilton rocks. On its east side, is a low ridge of Hamilton, Oriskany and Lower Helderberg, which culminates in a lofty cone beyond the State line. A valley, eroded in the Clin-

ton, intervenes between this and Wills mountain, where the Medina is shown dipping westward at a high angle. The whole of this space for nearly a mile northward from the State line is covered by forest.

Occasional exposures of Oriskany and Hamilton occur on the west side of the "bottom," while west from the county road high ridges of Chemung rocks rise; but neither stream nor path affords opportunity for exploration of these ridges near the State line.

Following the road, one comes to fair exposures of the Hamilton near School-House No. 1, and reaches Oriskany at the railroad. Thence, that sandstone is followed by the railroad to the first bridge over the creek and by the county road to fully 100 rods north from School-House, No. 2. As shown in the railroad cuts, the Oriskany is a calcareous grit, blue to reddish blue, and containing great abundance of the characteristic fossils. It does not yield readily to atmospheric influences, but eventually the lime is leached out, the iron peroxidized and the rock becomes a soft red sandstone; the fossils are reduced to powder and only tender casts remain in the sandstone.

The Hyndman axis begins immediately north from School-House No. 1, and its course is marked by a ridge whose slopes are Oriskany and its body Lower Helderberg. Marcellus shales on the east side occupy part of the "bottom" of Wills creek, dipping east on the west side, but westward on the other side where they rest against the ridge of Siurian rocks following the foot of Wills mountain. Here Wills creek flows across the synclinal.

The country road almost touches the Lower Helderberg at 30 or 40 rods north from Mattingly's grist-mill, but there it bends eastward and lies in Oriskany to School-House No. 2, where the road to Cook's mills turns off toward the east. Along the road the Marcellus shales of the Hamilton are shown just beyond the creek, where they dip eastward at nearly 20 degrees; but, immediately beyond the Methodist church an exposure shows them dipping westward at 55 degrees. Here they are black and fissile and, as so often happens, they have been regarded as indicating the exist-

ence of *coal* in the immediate vicinity. The broad "bottom" of Wills creek is reached at this place and thence no exposures were found until beyond Cook's mills. But the Oriskany, imperfectly exposed in a low hill north from the road, is passed before reaching the mills, so that there one is in the Lower Helderberg. Thence northward to where the new county road first crosses Wills creek the "bottom" has been eroded in Clinton and Lower Helderberg, while further north to Hyndman it lies in Clinton alone.

An exposure of Lower Helderberg was seen nearly opposite the first railroad bridge north from Cook's mills, in which the dip is north-west at 75 degrees; but at the first fork in the road, half a mile from the mills, the limestone is well exposed with a dip of 80 degrees. On the westerly fork, Mr. W. Devore quarries the gray fossiliferous limestone, which underlies a *Stromatopora* bed, and yields an excellent lime. A sample taken from this quarry was analyzed by Mr. A. S. McCreath with the following result:

W. Devore's Quarry in Lower Helderberg.

Carbonate of lime,	98.178
Carbonate of magnesia,	1.854
Oxide of iron and alumina,	0.114
Sulphur,	0.020
Phosphorus,	0.007
Insoluble residue,	0.230
Total,	<u>100.408</u>

thus showing the material to be of remarkably excellent quality.

The Oriskany is reached on the road passing Mr. Devore's house immediately above the first crossing of the little stream, where it is soft, ferruginous and breaks down into loose sand on exposure. The iron ore evidently underlies the upper bed of the mass. The Marcellus shales rest against the Oriskany with a westward dip of 70 degrees, which quickly decreases to 50 degrees. The opposite side of the synclinal is reached within 350 feet and at the next crossing of the stream the shales are almost vertical with an eastward dip while within a few yards further the

Oriskany is again reached. One comes to the Lower Helderberg on this road about opposite to J. Fichtner's house.

This synclinal rapidly becomes shallow northward, and the Oriskany sandstone finally runs out in a hill south-east from Mr. J. Cook's house.

Returning to the Wills creek road, one finds no exposures until he comes to the first crossing, but the "bottom" moves further eastward until it touches the Medina at the foot of Wills mountain. At and south from Cook's mills the Medina sandstone dips at a high angle, but the rate of dip diminishes northward, so that where the Bedford division of the Pennsylvania railroad reaches that rock the dip is barely 45 degrees. The Medina is bare for a long distance and the surface of many of the layers is beautifully *wave-marked*.

The creek "bottom" becomes narrower at a little way above J. Cook's house and the Clinton rocks form part of the ridge which bounds it at the west, while the "bottom" encroaches on the Medina at the east, so that the sandstone is exposed in the creek bed at G. S. Shaffer's saw-mill. While the creek has been moving toward the Medina, that rock, owing to decreasing dip, has been extending further westward. From Shaffer's mill to the bridge opposite Hyndman the western edge of the Medina exposure lies west from the Bedford division of the Pennsylvania railroad.

Fossil ore has been found on the farms of C. Shaffer, John Evans and Samuel Evans, but no attempt has been made to ascertain its value. The red shales closing the Clinton lie at but a few rods east from the road at John Evans' place, while the limestones belonging to the upper part of the group are exposed at the roadside and are burned into lime by Mr. Evans. The dip is only 26 degrees. The Clinton yellow shales are well shown in the road just south from the Brick-Works in the southern end of Hyndman and they underlie the greater part of that borough.

Going southward from Hyndman on the west side of the valley, one follows the Lower Helderberg for nearly half a mile. At the quarry of the Peerless Company, just beyond

the borough, the rock is dipping westward at 85 degrees, but the dip diminishes nearer the road where it is only 55 degrees. Before reaching John Evans' house the road crosses the imperfectly exposed Oriskany, and thence for a mile lies in the Marcellus shales, which are well exposed in a bluff behind Mr. Evans' house. They are shown in the road at a little distance further south, where they dip eastward at 20 degrees. They underlie Sam'l Close's house, beyond which the dip changes to westward and varies from 70 to 50 degrees, there being a sharp pinch at the summit of the fold.

The road returns to the Oriskany at J. Devore's and thence to Palo Alto it lies sometimes on Oriskany and sometimes on Lower Helderberg. The upper part of the Oriskany was seen just north from the house belonging to Mr. J. Wilhelm, Sr., where it contains many excellent fossils and is very ferruginous. Lumps of *brown hematite* occur plentifully in the road.

Turning westward at Palo Alto and following Gladden's run, one finds Lower Helderberg in the road and in the stream bed, while Oriskany is exposed in a bluff, 110 feet high. It dips westward at barely 15 degrees but is somewhat contorted. Beyond this is a bottom in which everything is concealed until at the house of Joseph Wilhelm's heirs the Lower Chemung rocks are shown in the creek bed with vertical dip. Occasional exposures show the same dip further up the stream until just below B. Lowry's house the *Chemung conglomerate* is reached. The exposure of this rock in place is incomplete, but great masses of conglomerate are strewn thickly over the surface below the house.

The brown flaggy sandstones of the Catskill are shown at several localities above this, but are not so characteristic as at many other localities further north. The red shales of this group are rarely exposed along this run. The Pocono was reached at the house belonging to the Winter heirs, but its upper limit was not determined, as everything above this is concealed by débris from the Pottsville con-

glomerate, which lies at but a little way beyond the Somerset county line.

Going southward from Palo Alto, one finds the Lower Helderberg limestone in the creek and dipping westward at 10 or 12 degrees; but at barely half a mile from the village the road turns sharply eastward and passes through a low ridge, so that, where it again turns southward, the Oriskany has been reached and is dipping eastward at 38 degrees, which quickly becomes 45 degrees. From this point to School-house No. 2, the road runs on the Oriskany, while Lower Helderberg is in the hill lying west from the road, and Marcellus shale occurs in the "bottom" of Wills creek.

Going northward from Hyndman, one soon crosses Wills creek and at the Baltimore and Ohio railroad is in the Marcellus shale. Following the Baltimore and Ohio railroad from the Somerset county line to Hyndman, the following section was made out:

B. & O. R. R. section from Hyndman westward.

XII. Pottsville conglomerate.

1. Conglomerate, not fully exposed, estimated at . . . 75
This was seen on the hill at Williams' Station immediately beyond the county line. For the most part it is very coarse, with pebbles numerous and as large as peas. Several layers are made up of pebbles smaller than buckshot, cemented by a small quantity of silica. This rock contains impressions of *sigillaria*, which are carbonized.
2. Coal bed, Mt. Savage, 4'
The openings in this bed are no longer in condition to be examined. At an opening near the present entry to the clay mine, the thickness was found as given, but the coal proved too inferior to repay working and all the pits were abandoned. Fragments of the coal seen on the dump show it to be broken by many thin pyritous layers.
3. Shale, 5'
4. Fire clay. From zero to 15'
Usually the clay bed is from 10 to 15 feet thick, but occasionally the overlying conglomerate cuts out the coal, the shale and the fire clay. One of these horsebacks seen at the mouth of the entry has cut away all but five feet of the clay. Concretions of iron occur, which weigh from a few ounces to more than a ton.

The clay is hard throughout, but varies in quality, often only about one third of it being fit for the manufacture of the best fire-brick, the rest making bricks of the second grade. A large amount of this is mined for shipment to the extensive fire-brick works at Hyndman and Meyersdale.

5. *Coal bed*, 0' 8"

This is shown in the clay mine wherever the floor is removed to gain passageway under a sandstone "horse-back." It is of better quality than the *coal* from the upper bed. The thickness varies from 2 to 8 inches.

6. *Shale, exposed imperfectly*; estimated at 5'

7. *Conglomerate, estimated at* 80'

The upper part of this mass is exposed along the chute from the clay mine to the railroad, but the lower part is concealed. The thickness is not far from exact, for the red shales are shown first at but a few feet below the line taken as the base of the conglomerate. This No. 7 is not so coarse as No. 1.

XI. *Mauch Chunk red shale.*

8. *Imperfectly exposed*, 120'

This contains a few exposures of red shale, but they are far from being satisfactory.

9. *Red shales and sandstones*, 18'

Shown at the first bench on the chute,

10. *Concealed to railroad track*, 127'

The rocks are rising eastwardly quite rapidly, but the exposures do not suffice to show the rate. The Savage Mountain synclinal axis is crossed at about one fourth of a mile below Williams' station, where the bottom of the conglomerate is not more than 100 feet above the track. Thence no exposures were found for fully one third of a mile or until the Somerset county line was reached at the great bend of Wills creek. There the conglomerate is shown on the hill top and the whole of the concealed interval is about 137'.

11. *Red shales with some sandstone*, 25'

12. *Sandstone*, 10'

Red, micaceous, argillaceous, somewhat pebbly; contains nodules of ferruginous clay with pipes of indurated clay in bundles; dip, 15, N. 40° W.; passes into

13. *Sandstone*, 20'

Reddish, mostly in thick layers, though becoming flaggy toward the base. Though not very hard, would be a good building stone.

14. *Red mud beds*, 10'

15. *Muddy sandstone, red micaceous*, 15'

16. *Like No. 12, with nodules so numerous as to make it conglomerate. An included layer of gray sandstone contains plant stems.*

17. Red shale, 10'
18. Sandstone, mostly flaggy, cross-bedded; upper part gray but lower part red, 20'
19. Red shales, vary at expense of underlying beds, but at one place are cut by overlying sandstone, 7' to . . . 11'
20. Sandstone, red, mostly flaggy, ferruginous, contains pockets of the nodular conglomerate on top, . . . 20'
21. Concealed horizontal distance of 2725' with dip of 15°, . . . 705'
22. *Silicious limestone*, visible 10'

This is partly exposed in the bank of Gooseberry run, where that stream is crossed by the railroad, as well as in the sides of a railroad cut just beyond the run. The rock has its characteristic blue tint, is fine-grained, but is certainly less calcareous than at the Youghioghenygap through Chestnut ridge in Fayette county. It weathers like limestone.

Gooseberry run heads in the west side of Savage mountain within Bedford county, and the Pottsville certainly reaches it. The fire-clay has not been opened there but in all probability it occurs there, as it does immediately beyond the county line. No. 22 is taken as the lowest member of the Mauch Chunk, but it has a close affinity to the Pocono, which begins with the next bed.

X. *Pocono grey sandstone.*

23. Sandstone, 25'
- This is exposed in the first cut below Gooseberry creek at nearly half a mile below the 194th mile-post. The rock varies in color from light to dark gray and grayish-blue; it is irregularly bedded, and contains some shale. A thin bed of sandy shale at 8 feet from the top is very carbonaceous.
24. Ferruginous shale, 8' to 10'
25. Sandstone, 35'
- Gray, weathering brownish-red, passing downward into gray micaceous flaggy to shaly sandstone. Dip about 20 degrees.
26. Imperfectly exposed, contains much sandstone, mostly gray and flaggy. One exposure of about 20' occurs immediately below 193d mile-post. Dip taken as 20 degrees. Horizontal distance 1925', 650'
27. Wholly concealed, 200'
- Dip taken as 35 degrees; horizontal distance, 350'. This interval probably contains the lowest beds of the Pocono as well as the highest beds of the Catskill. In it the dip rapidly increases. The next exposure shows a wholly different kind of rock, which undoubtedly belongs to the Catskill.

IX. Catskill red sandstone.

28. Sandstone, 15'
Flaggy, cross-bedded, micaceous, brownish, contains some shale. Dip, 48 degrees, N. 45° W.
29. Wholly concealed. Dip 50 degrees. Horizontal distance, 412', 310'
30. Sandstone and shale, 1655'
At top this is flaggy sandstone, gray to brown alternating with reddish shale and dipping at 55 degrees. Lower down, shales predominate, the sandstones become red, micaceous, soft, argillaceous and ripple-marked. Some of the shales are fossiliferous, and deep blood red with spots of white. Thin beds of grayish-white shale occur near the middle, and similar beds near the bottom are from one to two feet thick. *Modiola angusta* was obtained from one of the highest layers. The dip becomes 65 degrees at 60 feet from the top. The exposure is almost complete in the railroad side-cutting. Horizontal exposure, 1837'.

VIII. Chemung and Hamilton shales.

31. Reddish to gray shale and yellowish sandstone, Chemung, 30'
32. Wholly concealed, 2600'
This continues for a horizontal distance of 2875 feet and terminates at the road leading northward from Hyndman to Wills creek station. It contains the Chemung and Hamilton as well as the upper part of the Oriskany; but no exposures of even the *Chemung conglomerate* were seen, though fragments of that rock and of the olive shales occur plentifully in the débris-cuts along the railroad. The Marcellus shales are exposed on the county road north from the railroad. Immediately beyond this long concealed interval the Oriskany sandstone is shown alongside of the railroad dipping very gently south-eastward, barely 15 degrees.

VII. Oriskany sandstone.

33. Sandstone, estimated at 40'
This upper part of the Oriskany is a soft, coarse to conglomerate sandstone, ill-exposed on the railroad, but better shown on the county road near the railroad. (The section continues along the railroad.)
34. Bluish grit, few fossils 6'
35. Sandstone, 80'
Mostly grit-like, very hard, blue to gray, some layers pebbly; fossils numerous throughout, but especially so in several thin layers; among these the more common forms are *Spirifer arrectus*, *Spirifer arenosa*, *Rensselaeria ovalis*, *E. Suessana*, *Strophodonta magnifica*.

36. Sandstone, 8'
- Fine-grained, gray, yields readily to the weather and comes soft; fossiliferous; dip 82 degrees N. 50° W.
37. Hard grit, weathering jaspery; contains *Strophodonta magnifica*, 10'
38. Blue grit, 10'
- (A short fold occurs here which involves the next bed below.)
39. Sandstone, 34'
- Fine-grained, dark blue; contains ferruginous layers which yield readily to the weather. It is richly fossiliferous, containing among other forms, *Eatonia singularis*, *Leptocoelia flabellites*, *Rensselaeria ovalis*, *Rensselaeria suessana*, *Spirifera arenosa*, *Streptorhynchus hipparionyx*, and in some layers impression of *fucoids*. A layer is shown at 28 feet from the top, which is crowded with *Platystoma ventricosum*, and *Platyceras*. This passes gradually into the Lower Helderberg, the next being the bed of passage, which has some features belonging to both groups.
40. Silicious limestone, 20'
- Very cherty, the cherty part beginning fairly at 3 feet from the top. The upper part contains *Spirifera arenosa*, *Platyceras* and *Favosites*. This is well exposed where the cliff turns eastward at the railroad bridge.

VI. Lower Helderberg limestone.

The upper part of this group is well exposed between the two railroads in a bluff, where the Peerless Limestone Company of Pittsburgh has opened two extensive quarries and has made great strippings. The section continues:

41. Dark blue flaggy limestone, not quarried, dip 85 degrees, 40'
42. Mostly shaly limestone, not fully exposed, 20'
43. Flaggy limestone, 25'
44. Limestone, gray, weathers white; weathered surface shows many stems of *crinoids* and sections of *Pentamerus*, 20'
45. Limestone, dark blue with conchoidal fracture; few fossils, 22'
46. "Fossil limestone," gray, contains indistinct fossils, 12'
47. Blue irregular bedded limestone, with *Stromatopora*, 37'
48. Flaggy limestone with some shale, 25'
49. Limestone upper part dark gray, with streaks of calc-spar, lower part blue, 40'
50. Flaggy limestone, 25'
51. Gray limestone, 45'

52. Flaggy cherty limestone,	25'
53. Imperfectly exposed, some blue flaggy limestone, . .	66'
54. Blue flaggy limestone, weathers whitish,	15'
55. Shaly argillaceous limestone,	10'

Here the exposures end. The base of the group lies at some distance beyond the Pennsylvania railroad, but its place could not be determined, owing to erosion of the broad "bottom" of Wills and Little Wills creeks, in which everything is concealed.

The quarries are in Nos. 49 and 51. No. 46 yields a lime of superior excellence but it is not quarried. The limestone is shipped in large quantities to Pittsburgh where it is used in the iron furnaces.

Following the county road northward from Hyndman one soon crosses the Oriskany and at Wills Creek station is in the Lower Helderberg. Both the black and the yellow shales of the Marcellus are shown on this road between the Baltimore railroad and Wills Creek station on the Bedford railroad; and Oriskany is fairly well exposed at the roadside as one descends the hill towards the station.

On Jennings's run, which enters Little Wills creek at the station, the Hamilton is not exposed, and the olive flags at the bottom of the Chemung are shown in the first ridge, where they dip westward at 65 degrees. These flags are finely shown for a long distance between the first ridge and the second, that formed by the *Chemung conglomerate*. The latter ridge is as bold here as it is at the localities south from Wills creek, but the rock was not seen in place and no determination of the dip could be made.

The Pottsville conglomerate is not far from H. Emerich's house, and the Savage mountain fireclay should occur there on top of the ridge. Fragments of it are found occasionally.

A limestone quarry in the Lower Helderberg was seen on W. Carpenter's property, just north from Wills Creek station; and at a short distance further north the same limestone is quarried by the Willmetto Limestone Company on J. Carpenter's property. At this latter quarry the rock dips eastward at from 15 to 20 degrees, while at the creek the dip is westward at somewhat less than 30 degrees, a

noteworthy change from the conditions at Hyndman where the beds are vertical. The limestone quarried here for shipment is blue and contains much calcspar. A gray semi-crystalline bed occurs with this, but its thickness varies. A specimen of the blue limestone was taken, which was analyzed by Mr. A. S. McCreath, with the following result:

Willmetto limestone quarry, No. VI.

Carbonate of lime,	89.635
Carbonate of magnesia,	1.876
Oxide of iron and alumina,	0.610
Sulphur,	0.022
Phosphorus,	0.005
Insoluble residue,	6.880
Total,	99.028

Here the "bottom" of Little Wills creek is eroded in Oriskany, Hamilton and the Lower Chemung. The Lower Helderberg forms a line of hills extending to the northern line of Londonderry township, but exposures of Oriskany are rare until one passes Fossilville, beyond which for some distance, the "bottom" is very narrow. The first Chemung ridge is very bold and the road follows its base for half a mile above Jacob Carpenter's house. Fragments of *Chemung lower conglomerate* occur on the eastern slope. The dip at the road is but 30 degrees westward. The road on this west side of Little Wills creek lies in Chemung up to School-house No. 6, where it enters the Hamilton beds, which there are dipping westward; but at the fork of the road, one mile further up the stream, the dip is 70 degrees and eastward. The Oriskany is shown at the railroad crossing, and thence to the township line the road lies in Lower Helderberg, which shows the Hyndman anticlinal.

On the road turning westward at School-house No. 6 the *Chemung conglomerate* is reached at 120 rods above the second house, where its dip is only 25 degrees; the rock makes but an insignificant exposure and appears to be less massive than at most other localities within this portion of the district. Exposures are indefinite from this point to the clearing near School-house No. 7, where Catskill rocks prevail. Thence to the township line only Catskill was

seen. The outcrop of the higher rocks is at the south, and the Pocono forms the rim at the northern termination of the bold Savage mountain, of which the Pottsville forms a higher bench near the county line.

The Cumberland Coal and Iron Company mined the *fossil ore* at Fossilville, but owing to the bankruptcy of the company, the works were idle when visited and no examination could be made. The tunnel reaches the ore at a distance of 70 or 80 feet from its mouth and the ore has been followed for fully 1100 feet. The bed mined is the highest of the group, and varies in thickness here from 6 to 18 inches, but ordinarily averages about 15 inches.

On the county road turning eastward from Little Wills creek at barely a mile north from Fossilville, the Oriskany sandstone is reached on J. J. Wolford's property, where its dip is eastward at 80 degrees. This is clearly an overturn, for the Lower Helderberg is exposed beyond, and is vertical on Adam Wolford's property, where it has been quarried and burned. The top of the Clinton group passes very near to Adam Wolford's house, and the *fossil ore* has been mined at about 50 to 60 yards further up the road. The work was idle at the time of examination, but some ore lay on the dump and a large quantity lay alongside of the railroad at Little Wills creek. The bed averages about 18 inches, but occasionally becomes 23 inches. The ore is clean, fine-grained and some of it steel-like in color. The ore as sampled yielded on analysis by Mr. McCreath:

Adam Wolford's fossil ore.

Metallic iron,	45.225
Sulphur,	0.025
Phosphorus,	0.454
Insoluble residue,	21.620

which shows a large proportion of silicious matter.

Brown hematite occurs on the farms of J. J. and Adam Wolford in the Lower Helderberg. Some of it has been taken out for shipment. The quantity appears to be considerable and the ore is reported to be good.

A white sulphur spring issues from the Lower Helderberg rocks below Adam Wolford's house, but the quantity

of water is not great and the mineral constituents are apparently unimportant.

Following the road above Adam Wolford's house, one soon enters the gap through Buffalo mountain and reaches the Medina sandstone. The only exposure of the Upper or White Medina in place shows the dip to be almost 90 degrees. The lower division of the group, consisting of red rocks, shales, and grits, weathering with pitted surface, forms a terrace or secondary ridge on the east side of Buffalo mountain. The whole of the Medina has been passed before the first clearing has been reached, so that there the Hudson shales are shown. These are shown frequently between this place and the summit, which is the divide between Little Wills creek and Buffalo creek.

Here one passes from Londonderry into Harrison township and enters Milligan's cove.

Harrison township.

In Milligan's cove.—The Medina red rocks form a terrace on each side of the cove to its northern end where the two ridges, Wills mountain and Buffalo mountain again come together, forming a clumsy knob, which rises above both ridges and is composed of the red Medina beds.

Going northward through the cove, one finds no distinct exposure until beyond the property indicated on the county map as belonging to Miss Miller. A good exposure occurs there and the slates are dipping eastward, showing that the axis of the Wills Mountain anticlinal must lie west of the road. The Utica shales are shown at a little way further north, and at an exposure 100 rods south of J. E. Miller's house they are dipping S. 35° E. at 35 degrees. The Trenton limestone is shown in the road for a few rods immediately south from Mr. Miller's house.

The axis passes very near this house, for at half way between it and E. B. Miller's house the shales are shown dipping almost northwest at 70 degrees, and they are well shown with similar dip where the road leading to Buffalo Mills turns off.

Following this road, one finds shales until 30 rods below

Arnold's tannery, where they are succeeded by the hard sandstones and grits of the Lower Medina. These continue for 50 rods beyond the saw-mill in the gap made by Buffalo creek through Buffalo mountain. The Upper Medina is not shown in place.

Mr. John Cessna has opened the *fossil ore* just below the mouth of the gap on land belonging to Mr. Jacob Hardman. The section obtained here, according to Mr. John Lampen, who superintended the work, is

Ore,	1' 6"
Sandstone and shale,	2' 0"
Ore,	0' 2"

The ore of the upper bed averages not far from 15 inches. It is fine-grained, and for the most part the fossils are indistinct. Much of it is bright red, and specular iron is present in considerable quantity. A good deal of the ore lies on the dump still, though the works have been abandoned. This was carefully sampled and the material sent to Mr. A. S. McCreath for analysis. The following is the result :

Jacob Hardman's fossil ore.

Metallic iron,	49.875
Sulphur,	0.013
Phosphorus,	0.422
Insoluble residue,	13.890

The lower bed was not mined, but its ore is said to be very like that obtained from the other. No traces of a third bed have been discovered ; but exploration is attended with much difficulty as the coating of Medina débris is very thick. For the same reason, it was found impossible to fix the top of the Clinton definitely ; but the rocks of the Red ridge first appear at barely 40 rods above Mrs. Getty's house, and thence almost to the road passing north and south through Buffalo Mills one is on the Lower Helderberg. This rock is shown imperfectly, but at an exposure alongside of the road the dip is almost vertical.

Returning to Milligan's cove, one rides on Utica shale from the forks of the roads to the White Sulphur Springs and the road lies west from the axis of Will's mountain, for at all exposures the dip is westward.

Two springs, reputed to be of medicinal importance, were seen on Mr. A. M. May's property. These, as well as the better known Reed and Lyon *White Sulphur Spring* will be found described in another part of this report. Fragments of the White Medina were seen in the Sulphur Spring gap soon after passing the hotels, but no exposures of the rock in place were found.

Fossil ore bed.—An opening in the Clinton ore was made by Mr. John Cessna at a few rods below the mouth of the gap. Evidently only a little work was done in this mine and no ore lies on the dump. According to Mr. Lampen the ore was not found in place, and the opening was made most probably on the crushed and distorted "lap." The top of the Clinton is reached at about 30 rods from the house belonging to the Anderson heirs; and no further exposures were found until Oriskany was seen on the road leading northward to Mann's Choice.

Northward from Sulphur Spring gap, few exposures were found in Milligan's cove.

The area of Hudson River slates, No. III, narrowing in that direction practically disappears beyond the gap leading through Buffalo mountain to Mann's Choice. The subordinate ridge following the east side of Buffalo mountain becomes more distinct near that gap, where it is known as Summer mountain, but beyond it is soon merged into the common ridge. The Upper Medina is shown in the gap, but the exposure does not give the dip. Some digging was done several years ago below the mouth of the gap in search of the Clinton ore, but it was unsuccessful. The top of the Clinton group was reached at about 40 rods from the second bend in the road east from the turnpike; and thence to the pike, exposures of the Lower Helderberg are common.

Juniata township.

Returning now to the region lying west from Buffalo mountain, one finds Wolf Camp run entering Little Wills creek at 3 miles above Fossilville. Hamilton and lower Chemung rocks are shown along this stream from its mouth to where one crosses from Londonderry into Juniata.

Exposures along the run are numerous in this township; but within a short distance from the township line the Catskill rocks are reached, consisting of thin, flaggy, more or less cross-bedded sandstones. The dip is gentle, varying from 10 to 15 degrees. The axis of the Savage mountain synclinal is crossed by the run between Emerick's and Lafferty's mills, at one third of the way below the former. The outcrop of the *upper Chemung conglomerate* was seen at Mr. Thomas' house on the ridge between this run and Little Wills creek, very near the corner where Londonderry, Juniata, and Harrison townships join. The course of Wolf Camp run above Schroyer's mill is from the south-west.

Here no exposures were found and the map has been colored conjecturally.

Leaving this run at Schroyer's mills, one rapidly rises on the dividing ridge and finds himself in undoubted Catskill rocks at E. Turner's house. On the other side of the ridge one comes to Little Wills creek, which heads near West End post-office on the Dry Ridge pike. Along the stream Chemung rocks are shown from the pike for some distance, but the exposures soon become unsatisfactory. The dip is abrupt near the pike but quickly decreases, so that at the house belonging to the Anderson heirs it is south-east at only 16 degrees. The western outcrop of the *Chemung conglomerate* should be shown in the ridge crossed above the first fork in the road, but no exposure occurs, although fragments of the rock are numerous in the débris covering the hillsides. The laminated sandstones of the Catskill are fairly well exposed near Mrs. Mull's house and better exposures occur further down the creek. The eastern outcrop of the Chemung conglomerate was seen near Rockvale at A. Skelly's house, back of which it forms a bold cliff. It varies from coarse sandstone to conglomerate; the former is white, very soft and breaks down readily on exposure, whereas the latter is hard, pale blue and contains fragments upwards of two inches in diameter, many of which are flattened. Immediately east from this the rocks are dipping westward at 25 degrees. Here, at Rockvale, the creek passes into

Harrison township

and there are no exposures thence to Bard, where the creek turns southward. The Oriskany sandstone underlies the railroad at this place, while the Lower Helderberg ridge is immediately west but affords no exposures. Little Wills creek valley south from Bard shows nothing. Prospecting for *fossil ore* has been done on Levi Carpenter's property for Mr. John Cessna, but the ore was not reached. The sandstone underlying it was followed until it gained a regular dip, but at that point water became so troublesome that the work had to be abandoned.

Northward from Bard the road lies wholly in Hamilton shales, which describe a close anticlinal. The Oriskany is reached near Buffalo Mills, and thence to within a few rods of Mann's Choice that rock is occasionally exposed. Just south from Mann's Choice the road turns to the Lower Helderberg and remains in that rock to beyond the Juniata river. The limestone is quarried immediately north from Mann's Choice by Shoemaker & Co. to be burned for agricultural purposes. Samples from this quarry were sent to Mr. A. S. McCreath for analysis. The following was found to be the composition :

Shoemaker & Co's. limestone, No. VI.

Carbonate of lime,	92.875
Carbonate of magnesia,	1.891
Oxide of iron and alumina,	0.370
Sulphur,	0.030
Phosphorus,	0.005
Insoluble residue,	4.810
Total,	<u>99.981</u>

The quarry is at but a little distance east from the pike and there the dip is 72 degrees almost north-west, but at the road it is sharply eastward. The axis of Hyndman anticlinal is shown on the pike in Napier township beyond the Juniata river.

The old Wheeling pike in going westward from Mann's choice follows Dry ridge, a bold ridge lying south from the Juniata river and continuing westward into Somerset

county. It attains its greatest altitude within Juniata township east from West End post-office, and owes its existence to the northern outcropping of the Chemung rocks in the Savage Mountain synclinal. At the first fork in the road, almost immediately after leaving Mann's choice, one finds a close synclinal in the Marcellus shales, but the crest of the petty anticlinal beyond was not seen. This is similar to the narrow but abrupt anticlinal seen in the same shales near the school-house above Fossilville in Londonderry township. Exposures continue indifferent for more than a mile, but near the Powell school-house the variegated shales of the Chemung are shown at many places in the road. They rise westward from that school-house to a few rods beyond the township line, where the anticlinal which divides the Savage Mountain synclinal is crossed. Here one is in

Juniata township.

The anticlinal is marked by an abrupt squeeze in the shales. A thin somewhat ferruginous bed, containing *ambocoelia gregaria* in abundance, is characteristic and can be followed without difficulty from the school-house to the crest of the fold. Beyond the axis exposures again become poor, but the variegated shales are occasionally shown with the *ambocoelia* layer. The axis of the western division of the Savage Mountain synclinal is crossed very near the old toll-gate, where fragments of the *lower Chemung conglomerate* are shown in the road. The *upper* or *great conglomerate* lies south from the pike and its outcrop is distinct from where it bends westward near Bard to where it curves southward in the west side of the Savage Mountain synclinal. Its bold ridge is a noteworthy feature of the scenery.

Dry ridge rises from the toll-gate westward to within less than half a mile of the West End post-office, and fragments of the lower Chemung conglomerate are shown at many places while the shales show no marked variation in character. The highest point is reached just beyond J. Hillegass' house and thence the surface falls off quickly to West End, where the ridge is but a sharp divide between Little Wills

creek and a tributary to the Juniata. The eastward dip at West End is abrupt, an exposure showing 45 degrees S. 70° E., but it diminishes rapidly westward and at a little distance becomes only 20 degrees. The eastward dip continues to the Somerset line where the Savage Mountain anticlinal is reached and the direction is changed to north of west at 10 degrees. Between West End and the county line variegated shales occur holding flags, some of which contain *mollusks*, while others are covered with rude casts of *furoids*.

Descending from West End, the Old Drove road leads to the Juniata river, and the deep side cuttings expose the Chemung shales and flags, many of which are crowded with well-preserved *fossils*. The dip is abrupt near West End but diminishes near the river, where the rate is only 15 degrees E. S. E. Fragments of the lower conglomerate occur here and there on the hillsides.

Fragments of the great or *upper conglomerate* of the Chemung occur sparingly among the rolled stones of the Juniata "bottom," showing that the bed lies at some distance beyond the Somerset county line. Occasional exposures of Chemung were seen as far as the road leading to New Buena Vista. Few exposures were found along that road, but fragments of the olive flags are numerous and the flags themselves are well shown in the road near Buena Vista.

Going eastward from New Buena Vista one soon reaches the Genesee shales on the west side of the petty anticlinal seen on the Dry Ridge pike, and these remain in sight to the fork of the road at the property of H. & P. Mowry. But there all exposures end and nothing more is seen until the Juniata river is crossed at the township line, where the road passes into

Harrison township.

Beyond the stream the laminated sandstones of the middle Hamilton are shown in the bank dipping S. 10° E. at 4 degrees. The Genesee shales are reached again at a gulch beyond the first house and remain in sight until Andrew Turner's house has been passed. The olive flags of the

Chemung are quarried on the road to Dry Ridge at a little way south from that house, where they dip almost south-east at 10 degrees and break into the characteristic shapes.

The thickness of the whole mass from this point to the Dry ridge pike calculated from the dip and distance is not far from 1400 feet, but the exposures are not complete and possibly a part of this interval belongs with the shales above. Certainly, the brown sandstone belongs in this interval.

Crossing the river at Turner's grist-mill, one enters

Napier township

and rides on Genesee shale to C. Wetstone's house, beyond which the sandstones of the middle Hamilton are shown in the bank of a run, dipping south of east at 25 degrees. The road, turning eastward at Mr. Wetstone's house, quickly rises to the olive flags, and lies in rocks of the Chemung series until it crosses the river into Harrison township, but beyond that it soon reaches the Hamilton shales again. These prevail along the river almost to where the old Wheeling pike enters Napier township. The Oriskany is crossed before the pike is reached and that road lies in the Lower Helderberg to where it joins the Pittsburgh pike. At the first house north from the Juniata on the Wheeling pike, rocks dip westward at 62 degrees and the crest of the Hyndman anticlinal is shown at the bend in the road beyond the old toll-gate. The axis crosses the quarry belonging to A. Stuckey, where limestone is obtained to be burned for farming purposes. Samples of this rock were forwarded to Mr. A. S. McCreath, whose analysis resulted as follows :

A. Stuckey's limestone, No. VI.

Carbonate of lime,	96.592
Carbonate of magnesia,	2.459
Oxide of iron and alumina,	0.240
Sulphur,	0.019
Phosphorus,	0.008
Insoluble residue,	0.930
Total,	<u>100.248</u>

The Juniata "bottom" is digged out of the Clinton and

the shaly part of the Lower Helderberg until it passes beyond the township line into

Bedford township.

Here it breaks across the Medina at the end of Wills mountain and passes into the Clinton. The features of this portion will be described in the next chapter.

The Bedford and Stoystown pike, or, as it is more commonly known, the Pittsburgh pike, reaches the west side of Wills mountain almost immediately after passing Wolfsburg. Clinton rocks alone are shown along this pike in Bedford township, where *fossil ore* has been mined extensively for the Kemble Coal and Iron Company. The Lower Helderberg rocks are shown at a few rods beyond the township line in

Napier township.

Here the Clinton rocks lie south from the pike. The *fossil ores* have been mined on Mr. J. Sill's property near the township line, but the work has been abandoned, temporarily at least, and no direct information could be obtained. The following is reported to be the section of the ore beds:

Sill's fossil ore bed.

Ore,	0' 10"
Shale,	0' 6"
Sandstone,	2' 0"
Ore,	0 to 1' 6"
Shales,	1' 3"
Ore,	0' 10"

Here the lowest bed is very good. The mining was done by stripping for the use of a furnace in Fayette county, Pennsylvania; but the ore is not rich enough to bear cost of transportation so far. The dip is N. 30° W. at nearly 45 degrees. The red rocks marking the summit of the Clinton are well shown in the road, where they alternate with yellow shales, and there appears to be little limestone underlying them.

Exposures are very poor along the pike until the first

fork beyond the old Wheeling pike is reached, where the Lower Helderberg limestone is quarried and burned for agricultural purposes. The dip is north-west at 75 degrees and the beds are somewhat contorted. The Oriskany is not exposed here, as a "bottom" has been eroded from the sandstone and the Marcellus. But the former is shown in a low ridge south from the pike. The laminated sandstones or sandy shales of the middle Hamilton are shown on the north side of the road at 50 or 60 yards further, where the dip is 78 degrees, soon becoming 85, but quickly decreasing to 55 degrees before the next fork in the road. No further exposures in detail were found until nearly 60 rods beyond the house belonging to the Diehl estate, where sandy shales, more or less clayey and holding thin layers of gray flaggy sandstone, were seen. These belong to the Chemung, but fossils are rare, there being only an occasional crinoid plate and *Ambocælia gregaria*.

The axis of the Savage Mountain synclinal passes very near the next house, indicated on the county map as belonging to Mrs. Sutter, where shales, olive and fissile, are shown at the roadside. The ferruginous layer with *Ambocælia gregaria* is exposed here. The rocks are dipping eastward at a little way further west, before the top of the hill has been reached, and the low hills are covered with fragments of the Chemung *lower conglomerate*. Some slabs here are fossiliferous, containing *Spirifera mesacostalis*, *Ambocælia gregaria* and *Streptorhynchus chemungensis*.

Brown sandstones with olive shales are shown at the first house beyond the next cross-roads. The sandstones, which have an eastward dip of 22 degrees, contain *Atrypa aspera*, *Atrypa reticularis*, *Streptorhynchus chemungensis*, *Ambocælia gregaria* and *Sanguinolites* with an occasional furoid. These rocks pass gradually downward into shales and flags which continue to beyond the next fork in the road; but the flags become less numerous toward the bottom.

The Genesee shales are shown at R. Colvin's house. They are very dark brown, in part fissile and hold thin flags of sandstone. The lower part is lighter brown, and passes

downward into olive shale with flaggy sandstone. This continues almost to Mr. Kemery's house, where the laminated sandstones of the middle Hamilton are exposed. These have an eastward dip of 15 degrees at the summit of the next hill, where a cut has been made through them. They rest on variegated mostly brownish more or less fissile shale, which continues until the broad bottom ends all exposures. The black or lower shales of the Marcellus are reached at Schellsburg and the Oriskany of Chestnut ridge is shown at the west end of that borough.

Turning southward at Schellsburg toward Colvin's mill, one rides on Marcellus, whose limestones are often exposed. The Oriskany is reached at the mill, where it rises from the stream bed. No exposures were found east from this until C. Wetstone's, where as already stated the sandy shale of the middle Hamilton is exposed in the bank of a run. The broad "bottom" made by the forks of Juniata and their tributaries have concealed everything.

Juniata township.

Still following the road southward from Colvin's mill toward New Buena Vista one finds the shales until he passes into Juniata beyond the Union school-house.

The Oriskany of Chestnut ridge disappears before the township line has been reached, so that beyond that line only Hamilton rocks are shown. The broad "bottom" of the middle branch of the Juniata afford no exposures until the stream itself has been reached beyond J. Miller's house, where Marcellus shales are shown dipping south-west at 6 degrees. The gray sandy shales with *Spirophyton* are fairly well exposed at half a mile further, while the Genesee shales are reached where the road turns toward New Buena Vista.

Returning to Colvin's mill in

Napier township

and ascending the middle fork of Juniata, one rides on Oriskany sandstone until he approaches Hughes' distillery, where the transition beds of the Lower Helderberg are

shown, as the creek cuts through the Savage mountain axis. But these pass under the stream within a few rods, and thence to the Pittsburgh pike only Oriskany is shown.

Crossing the stream at the pike one soon passes into

Juniata township

and reaches the Chemung flags within a few rods. The dip, where these were first seen, is westward at 30 degrees; but the rate gradually increases westward to 45 degrees and at the first fork of the road east from Burn's Mill post-office it is 65 degrees. There the rate decreases abruptly to 15 and then to 10 degrees, and the variegated shales of the Chemung are well shown thence to the crest of the ridge made by the *great conglomerate* of the Chemung. These shales contain flags but no thick beds of sandstone.

The *Chemung conglomerate* is shown imperfectly at the hill-top, say 125 rods east from the house belonging to Mowry and Hillegass. This rock enters the county on this west side of the Savage mountain anticlinal at somewhat more than a mile north from the Juniata river, and its bold ridge, gradually moving eastward, is a striking feature in the topography from that point northward into Blair county.

No good exposure of the upper beds of the Chemung was found on this pike, but the Catskill thin bedded sandstones are fairly well shown at not more than 50 rods west from the Mowry and Hillegass house. Thence to the toll-gate near the summit of the Allegheny mountain one rides on Catskill rocks, of which the sandstones are frequently shown. A massive sandstone belonging near the top of the group was seen below the bend in the road near the toll-gate, with a westward dip of barely 15 degrees.

The Pocono is reached near the summit of the mountain, but is imperfectly exposed. It enters the county from Somerset a little more than 2 miles south from the pike and thence to the Blair county line it forms the crest of the Allegheny mountain, which is the western boundary of Bedford county.

Along the face of the mountain north from the pike, no exposures were found before reaching W. Kinzie's house,

where Catskill sandstones are shown in the stream. No further exposures occur up to the township line.

Napier township.

Catskill rocks are seen again near L. Miller's house. The road continues up the mountain side past Miller's, and reaches the Pocono near the top, where that rock forms a cliff. It contains layers of conglomerate, but for the most part is comparatively fine-grained.

Going eastward from Miller's one rides on Catskill until within 100 rods of Millerton, but there are few exposures either of those rocks or of the upper Chemung beds on the Millerton ridge. The *Chemung conglomerate* is not shown in place though its ridge is as bold near Millerton as at any place south from Blue Knob. The rock is well shown at S. Wonder's shop, half a mile north from Millerton.

Few exposures were found east from Wonder's shop on the road leading thence to Chestnut ridge. The Chemung brown sandstones are shown near J. Hiner's saw-mill where they contain fine specimens of *Atrypa reticularis*. *Fucoids* occur abundantly on many of the flags below this to J. G. Smith's house, where the rocks dip westward at 25 degrees. The lower flags are shown at P. Hoover's house. Turning southeastward here towards Schellsburg to cross Chestnut ridge, one comes to the Hamilton sandy shales at Adam Smith's house, above which the Marcellus is imperfectly exposed on the side of the ridge. The Oriskany nowhere appears in place, but the Lower Helderberg is reached near the property belonging to Dr. Ealy. This, however, is the southern limit of that group, for the Oriskany is reached again within a few rods, and prevails thence to the summit of the ridge, as well as along the crest to the Pittsburgh pike, and along the pike to Schellsburg.

Northwestward from Schellsburg the Oriskany of the east side of Chestnut Ridge passes behind Mr. J. P. William's house, and its bottom is reached before the second bend in the road; but the rock is not exposed in place. No exposure of the Lower Helderberg occurs anywhere along or near this road, but the surface on both sides of the ridge is cov-

ered with spalls of the limestone. The Oriskany is reached on the west side of the ridge at about half a mile above J. Coster's house, and the western limit of the group is at the upper edge of his clearing. The upper part of the rock is ferruginous. Ore is present here in the Marcellus also and fragments of it were seen in the road near Coster's house. No exposures were found beyond this until School-house No 10 was reached, where the Chemung olive flags are shown dipping almost due west at fifty degrees.

The road lies in a broad "bottom" for most of the distance between that School-house and the village of New Paris, a distance of somewhat more than a mile, and no exposures occur. A road turns eastward at New Paris to cross Chestnut Ridge. Oriskany is shown in the village, and the Lower Helderberg is reached at about 40 rods from the first fork in the road. The limestone is cherty and contains among other forms, *Caninia*, *Favosites*, *Orthis*, *Rhynchonella ventricosa*, and *Pentamerus pseudo-galeatus*. The fossils occur mostly in sections on the weathered surface, and few of the species can be identified. The dip is gentle, and this bed continues in sight almost to the summit of the ridge. Exposures are indifferent on the east side, and the Oriskany sandstone is reached immediately beyond J. A. Blackburn's house, where it forms a hog-back ridge. The Marcellus is shown in the valley road, which lies in these shales from Schellsburg to beyond the township line, and affords frequent exposures of the shales and their limestones. At say half a mile from where the valley road is reached from Blackburn's, it passes into

St. Clair township

and comes to Spring Hope post-office. On the road turning eastward here, the Marcellus shales are shown dipping in that direction at 15 degrees. They continue to Blackburn's grist-mill, beyond which are shales weathering yellowish, which end at the fork of the road, where a ridge of Hamilton sandstones rises. These are laminated sandstones in layers one fourth of an inch to one inch thick and contain thin beds of gray sandy shales. The dip is S. 80° E.

at 15 degrees, and as far as examined the beds contain no fossils. This series occurs beyond the stream, a branch of Dunning's creek, and is succeeded by the Genesee shales, black to brown and partly fissile, which continue to the fork of the road at W. Border's house. There they are succeeded by Chemung beds, thin bedded gray shales with flags, above which are olive and yellow shales, some of which are fissile. These continue eastward from Border's for nearly 100 rods, beyond which all is concealed to near the summit of the ridge, where gray sandstone is seen dipping almost due east at 20 degrees. Thence no exposures were found until half way down the opposite side of the ridge where a yellow sandstone with *Atrypa aspera* occurs in thin beds.

Turning southward at the foot of the hill and following a tributary to Dunning's creek, one finds frequent exposures of brown to reddish brown sandstone shale and flaggy sandstone containing *Atrypa aspera*, *Atrypa reticularis*, *Ambocoelia gregaria*, and *Streptorhynchus chemungensis*. The dip is eastward throughout.

Turning eastward at the township line, the road climbs a high ridge of Chemung and for nearly two miles lies in Napier township; but it affords no exposures until it approaches the township line.

Bedford township

Here at M. Hazlett's house rocks very near the base of the Chemung are shown dipping westwardly. The Chemung conglomerates are not preserved in this synclinal, and no traces of them were seen in crossing the ridge. No further exposures were found near the road before coming to I. Semler's house, where the Marcellus appears, dipping westward at nearly 60 degrees. The Oriskany is concealed but the Lower Helderberg is quarried on Mr. Semler's property, where it dips westwardly at 60 degrees. The rate of dip diminishes rapidly and is but 12 degrees at the next fork of the road where the lowest member of the group is shown. Thence to Wolfsburg the road lies in the Clinton.

St. Clair township.

Returning to Spring Hope post-office (which derives its name from an immense spring which issues from the foot of Chestnut ridge) and going northward, one rides on Marcellus shale almost to Spring Meadow post-office. A road leaves the valley at the Hoover School-house, a mile and a half north from Spring Hope, and crosses Chestnut ridge. On this road, the Marcellus shale and its limestone beds are shown dipping eastwardly at 5 or 6 degrees. The Oriskany passes about 50 rods above J. O. Hoover's house and its bottom lies east from J. Miller's house ; but the rock is not exposed near the road, though on both sides its ridge is distinct. No exposure of any sort was found between this and the top of the ridge, everything being buried under a deep coat of débris, consisting mostly of limestone spalls.

Lower Helderberg limestone is quarried and burned on the west side of the ridge by R. W. Allison at whose quarry a gentle anticlinal is shown. Oriskany crops out at the cross-road and finally goes under before one comes to Dunning's creek, so that Hamilton shales are shown in the road beyond the creek southward into

Napier township.

Following the Dunning's Creek road in this township, one soon reaches the Oriskany, which continues to New Paris.

On the road leading west and northwest from New Paris, a knoll was seen at say 150 rods from New Paris, with rocks dipping westward at 35 degrees. These are probably Hamilton. Aside from this no exposure appears in the broad "bottom" of Dunning's creek. The *Chemung conglomerate* is shown on this road at say 30 rods above G. Carson's house where its ridge is distinct. The dip there is about 25 degrees but the rate diminishes until at P. Rowser's house it is less than 10 degrees. *Lamellibranchs* of Chemung type occur abundantly there. Fragments of a conglomerate were found near School-house No. 13 above which the Catskill rocks appear. Thence exposures are very bad, everything being concealed at most localities by Pocono débris, but the red shales and laminated sandstones are fairly well shown

at Nunemacher's tannery. At a little way above this the road passes the township line.

St. Clair township.

Here the old State road leads across the Allegheny mountain. Following it for a few rods, one comes to the Catskill bench which extends along the east face of Allegheny mountain from the Pittsburgh pike to Blair county. Little was seen above this until the Pocono was reached near the summit of the mountain, where it is a gray, moderately fine-grained sandstone with some shale and a few thin beds of conglomerate. The exposure is incomplete, and the top of the group lies beyond the crest in Somerset county.

Leaving this road and taking that which leads eastward to Six Roads post-office, one finds occasional exposures of Catskill to within a short distance of Moore's grist-mill. The limit between the Catskill and Chemung cannot be determined here and the two groups are absolutely blended. The dip is gentle, being only 18 degrees, N. 40° W. at the first fork in the road above the mill. The *Chemung conglomerate* is not shown in place, but its ridge is prominent, and débris from the rock covers much space just below the mill. Exposures are imperfect thence to J. Cuppett's house, where the Chemung is shown dipping westward at 40 degrees, as far as can be determined from the imperfect exposures. This dip steadily increases to Six Roads, where the rate is between 50 and 60 degrees.

The road leading from Six Roads across Chestnut ridge affords no exposures in the broad "bottom" of Dunning's creek, which is covered with fragments of Oriskany sandstone from the ridge. That sandstone appears in place at the bridge over the creek, and its dip at Mr. Oldham's house as well as can be determined from the weathered exposure, is westward at 25 degrees. A petty exposure of Lower Helderberg was seen at the first fork of the road in ascending the ridge, but it is a mere point due to erosion by a little stream, so that within a few yards Oriskany is again the surface rock. That sandstone prevails to Spring Meadow; and the northern limit of the Lower Helderberg limestone

is very near the forks on the crest. Fragments of *brown hematite* belonging to the Oriskany occur near T. S. Holsinger's house on the west side of the ridge. The dip of the sandstone at Spring Meadow is S. 40° E. at 18 degrees.

The valley road leading southward from Spring Meadow to Spring Hope and Schellsburg reaches the Marcellus at the Friends' meeting-house and follows that shale to beyond the township line. The Marcellus limestone occurs in thin layers,—is for the most part dark blue and so far as examined without fossils. Northward from Spring Meadow, the Oriskany is in the road almost to the mouth of George's creek. Westward from that point toward Pleasantville, exposures are rare. One near the Knisely school-house shows a dip of 12 degrees north-westward, and the Chemung rocks at Pleasantville have a but little greater dip. Southward, however, the dip increase regularly until at Six Roads it is between 50 and 60 degrees.

At the only exposure west from Pleasantville seen before reaching the Barefoot school-house the Chemung rocks are dipping north-westward at 35 degrees. The *Chemung conglomerate* is reached at that school-house, and thence the rate of dip diminishes so that it is barely 10 degrees in the Catskill beds near the upper Barefoot school-house on north branch of Barefoot run. Exposures below that school-house are scanty, as the hillsides are covered with great slips of the laminated sandstones, which dip in all directions. The Catskill bench is reached at the head of this north branch of Barefoot run, and there the road passes into

Union township,

where it joins the road leading across the Allegheny mountain.

The crest is of Pocono, which extends down the east side to nearly 200 feet below the summit and dips almost north-west at from 15 to 17 degrees. Fragments of conglomerate occur here and there on the mountain side, but the beds whence they come were not seen. The sandstones exposed are coarse but without any tendency to conglomerate. The shales of this group are reddish to brown.

Brownish red, flaggy to laminated sandstone is exposed occasionally between the Pocono crest and Mr. Barefoot's house on the Catskill bench.

Turning northward at the head of George's creek and following that stream one is certainly on Catskill rocks until beyond W. Hammer's house. No marked change occurs in the character of the rocks below that, but some slabs with Chemung fossils were found lying on the hill-side not far from the house. Occasional exposures of laminated sandstones were found to within a short distance of the junction of this with the other fork of George's creek. No positive line of separation between the two groups can be found here. The *Chemung conglomerate* is shown near the junction of the forks, where it is fully 40 feet thick and dips N. 30° W. at 17 degrees. A flaggy sandstone overlies it at nearly 50 feet and is shown 200 feet further up the stream, where it dips at only 15 degrees.

Chemung rocks continue on the other fork certainly to beyond the Mauk school-house, near which flaggy yellowish-brown sandstones were seen filled with Chemung *lamelli-branchi-ates*. Catskill rocks occur on the divide between this stream and Bobb's creek and are fairly well shown on the summit where crossed by the road to Bobb's creek. The dips are gentle on the north fork of George's creek, being little more than 8 degrees.

Following George's creek below the forks one soon comes again into

St. Clair township,

where exposures of the Chemung are frequent along the stream, though they are not such as to afford a satisfactory section. The lower rocks of the Chemung are shown near the Hoover School-house, where the dip is 12 degrees; but at J. P. Hoover's place the dip is very gentle. It becomes 20 degrees, N. 40° W. opposite Snyder's house, where the olive flags and shales are well exposed. These rocks form a well-marked ridge. No further exposures were found before reaching Mr. Vickroy's house, where the Marcellus shales are shown dipping gently northward. The axis of

the Savage Mountain anticlinal passes not far from this house.

The Oriskany does not extend northward to George's creek; at all events it is not shown in the vicinity of the road. The influence of the Savage Mountain anticlinal appears further north in the broad valley scooped out by tributaries to George's creek with converging hills of lower Chemung. One comes to the Marcellus shales again beyond the mouth of George's creek. They contain *septaria* at Mr. Reininger's place, where they yield *alum*. This locality has been known as "The Alum Bank" for more than 100 years. Thence exposures are very indifferent until one reaches Mr. Acker's house, near which the Genesee shales are exposed, while olive shales and flags of the Chemung are shown at the house. A synclinal occurs just below the house and the axis of the Pine Ridge anticlinal passes within a few rods below Ickes' gun-shop. Clayey beds exposed there contain *Chonetes* and impressions of *crinoid* stems. Very fair exposures of these beds continue to beyond the mouth of Bobb's creek, but thence to Pine Tree school-house everything is practically concealed. The olive beds are reached again at a little way beyond the school-house, where they dip S. 50° W. at 15 degrees.

Exposures are very bad from this place to near Griffith's at the foot of Black Oak ridge, a narrow ridge of Hamilton, Oriskany and Lower Helderberg extending from Dunning's creek northward to St. Clairsville. The sandy shales of the Hamilton dip westward at 85 degrees, while the Oriskany and Lower Helderberg are almost vertical. The latter group contains iron ore and a long trench was dug in search of *Lower Helderberg ore* along side of the road leading to Cessna post-office. The ore is said to be good enough, but its occurrence is irregular and too uncertain to justify mining. Crossing into

Bedford township,

one finds himself still on the Lower Helderberg. At less than a mile south from Cessna post-office a road leads west-

ward, which quickly crosses the Oriskany and reaches the Marcellus shale as it passes into

St. Clair township.

The Hamilton sandy shales are shown in this township before coming to P. Shriner's house and the Genesee shales are exposed at the house. Olive shales of the Chemung are reached before one comes to the next house, and at the exposure are dipping S. 80° E. at 65 degrees. This is probably an *overturned dip* and the axis of the Savage Mountain synclinal is not far from J. Bowser's house. Flags, belonging to the lower part of the Chemung, are shown at a little way above Mr. Bowser's house, where they dip eastward at 15 degrees. This dip is maintained until just beyond the next run, where, within four feet, the rate increases to 35 degrees, S. 40° E., but within ten yards the dip is reduced to 10 degrees. The exposure ends at barely 15 rods further and thence everything is concealed to some distance above M. Miller's house, where olive shales with flags begin and remained exposed almost to Mrs. Griffith's house.

The rate of dip increases above J. Miller's house but no good exposures were found beyond that for nearly one third of a mile. Where the road leaves the creek below Way's house, an exposure shows the dip to be S. 35° E. at 25 degrees. The rocks have the same character at all exposures thus far, being olive shales and sandstones, the latter carrying *fucoïds* which are always characterless. The same rocks are shown at T. Way's house and they evidently continue westward beyond C. Wolf's house. No exposures were found between this last house and Griffith's tannery, but in the interval the axis of the Pine Ridge anticlinal has been crossed, for the rocks dip westward, at the tannery. At this place the road crosses Dunning's creek and brings one to the Griffith School-house.

Bobb's creek enters Dunning's creek at a little way below the Griffith School-house. Few exposures occur on the west side of the creek above the bridge; but the hill on the west side shows the Chemung rocks dipping south-eastwardly, and occasionally yields a fragment of the *lower conglomer-*

ate of that group. The *upper conglomerate* appears not to be reached in the neighborhood of Bobb's creek within St. Clair township. The Hamilton group comes up further north under the influence of the growing Pine Ridge anticlinal, and the Marcellus shale is well shown toward the township line. Turning westward at the township line one rides on Hamilton shales and sandstones to J. Bowser's residence, beyond which everything is concealed. These shales are dipping S. 30° E. at 15 degrees near the Union School-house, where they contain *Nuculites*. Eastward from Bobb's creek at the township line Oriskany is shown in the road at 50 rods from the bridge, the southern termination of the Oriskany brought up by the Pine Ridge anticlinal. Thence to St. Clairsville, one rides only on Marcellus shale.

St. Clairsville is at the northern end of Black Oak ridge. Going eastward from St. Clairsville on the road leading to Bedford, one comes to the Oriskany at T. Hoenstine's house, beyond which the Lower Helderberg quickly comes up, and at once shows a sharp anticlinal, the most northern locality at which the Hyndman axis was recognized. Its crest is shown at L. Geisler's lime kiln. The eastern edge of the group is nearly 500 feet east from this kiln. A sample of this limestone was forwarded to Mr. A. S. McCreath for analysis. The following was ascertained to be its composition :

L. Geisler's limestone, No. VI.

Carbonate of lime,	94.107
Carbonate of magnesia,	2.444
Oxide of iron and alumina,	0.240
Sulphur,	0.036
Phosphorus,	0.010
Insoluble residue,	2.750
Total,	<u>99.587</u>

A bed of *fossil ore* has been opened on the Geisler property at about 1100 feet from the Lower Helderberg outcrop. It is thought to be the same with the "Frankstown" bed of Blair county and as far as seen at the time of
9 T^r.

examination it is 10 inches thick, with a westward dip of 10 degrees. Yellow shale occurs both above and below it. Another pit on the same property, but higher up the side of Dunning's mountain shows the dip to be 36 degrees. The horizontal distance to the Medina is not far from 600 feet. Fragments of "*block*" ore occur near the latter rock, but the bed was not found in place. Samples of the "Frankstown" bed were taken for analysis by Mr. A. S. McCreath. The composition is as follows:

L. Geisler's Frankstown ore.

Metallic iron,	49.550
Sulphur,	0.017
Phosphorus,	0.137
Insoluble residue,	20.530

This road enters the Clinton rocks immediately beyond Mrs. Bradley's house and thence the upper beds of that group lie between the road and Black Oak ridge, while the *upper ore bed* lies at a rod or two east from the road as one approaches the old Kaufman house, under which it passes. An exposure of the Clinton rocks at Weisel's house shows a dip of 50 degrees. Near the Kaufman School-house, the *upper ore bed* lies west from the road, and a gulch leads thence almost to the Medina of Brush mountain, as the southern prolongation of Dunning's mountain is termed. The *second ore bed* was found in this gulch at 600 feet from the first and the last fragments of the *block ore bed* were found at 450 feet further, making the whole thickness of the Clinton at this locality not far from 1,560 feet, as determined by stepping the distance. Doubtless the dip is somewhat less here than at Weisel's, as the rate decreases southward, but there are no good exposures by which to determine the matter. Only Clinton shales are shown in the road southward until Griffith's house is reached, where the Lower Helderberg beds are exposed. The dip of the Clinton shales near J. H. Griffith's house is only 28 degrees. The Orbisonia Company mines the *fossil ores* on the ridge west from this house, very near the line of Bedford township. The features observed here are similar to those seen

at the Kemble Company's mines in Bedford township, which will be described in the next chapter.

Going northward from St. Clairsville, one rides on Marcellus shale to the township line where he passes into

King township.

A road crossing Dunning's mountain from Morrison's cove joins the Hollidaysburg pike immediately beyond the township line. On this, the Medina is shown at the crest of the mountain, where it forms a comb and is nearly vertical. Further down, exposures are worthless and everything is concealed by débris until near the first fork in the road, where an exposure of Lower Helderberg shows a dip of 78 degrees due north-west. The Oriskany forms a low ridge behind the first house; thence nothing is shown until the Marcellus shale is exposed at the Hollidaysburg pike. This shale is shown also at Mrs. Colbach's house further north on the pike, as well as for some distance along a by-road leading to J. Imler's house. The exposure ends at barely half a mile further north, where the Oriskany has a loop-like outcrop, its most northerly exposure in the Savage Mountain synclinal. At a little way beyond Mrs. Colbach's, on the pike, the shales contain thin beds of brown to blue limestone which show distinctly the variations in dip. Where first reached, these are dipping S. 30° E. at 37 degrees; but nearer the bend in the road the dip becomes almost due south at 29 degrees. No fossils were seen in these limestones aside from a large *Aviculopecten* with a greatly extended wing. The Oriskany is crossed by the pike at a few rods further, but its exposure is indefinite and the dip was not ascertained.

The Lower Helderberg limestone is quarried for agricultural purposes by Mr. Hull at a little way above Ake's mill. The dip in the quarry is due south-east at 60 degrees. The bed, which is quarried, is clean, blue, and brittle and rests on a cherty limestone. Specimens analyzed by Mr. A. S. McCreath, have the following composition:

Mr. Hull's limestone, No. VI.

Carbonate of lime,	90.660
Carbonate of magnesia,	2.542
Oxide of iron and alumina,	0.822
Sulphur,	0.056
Phosphorus,	0.008
Insoluble residue,	6.250
Total,	<u>100.338</u>

This quarry is evidently very near the crest of an anticlinal as the limestone layers are bent sharply westward near the crest of the hill. The anticlinal is crossed by the road before reaching Mrs. Walter's house.

The structure between the pike and Dunning's mountain is somewhat obscure from this point northward to the county line. The ridges of Clinton and Lower Helderberg, so distinct in St. Clair township, are merged here and the mountain has a gradual slope from the valley to the foot of the Medina wall. The Oriskany is nowhere shown in place, but the large masses lying in the fields and on the low benches within 40 or 50 rods from the pike indicate that some patches of that rock may have escaped erosion. The *fossil ore* beds were opened by prospectors high on the side of Dunning's mountain, but they lie near the top of the bench and the pits have been filled for a long time. No information whatever could be obtained respecting either the thickness of the deposits or the quality of the ore. If the ore be good and thick enough to justify working, the available amount is enormous, as the breast above drainage is more than 700 feet.

Turning off on the road leading past G. Beegle's house to Imler's cross-roads, one rides on Lower Helderberg limestone to the summit of the ridge beyond Mr. Exline's house. No exposures in place were seen, nor is the Oriskany itself shown at the crest. The dip is gentle and that of the Oriskany on the west slope is too small to be measured by an ordinary clinometer. The sandstone shows *Spirifera arenosa*, *Spirifera arrecta*, *Megambronina*, *Eatonina peculiaris* and *Meristalata* at one exposure. Occasional fragments of bluish limestone were found between the summit and the cross-roads,

indicating that the Marcellus occurs somewhere well up the side of the ridge; but that rock has been removed for the most part and it was not seen in place until the cross-roads were reached.

In following the road westward from the cross-roads, the first good exposures in Long ridge were seen at Scrub Grass creek, where are reddish brown shales of the Chemung, holding flags of argillaceous reddish sandstone and dipping N. 20° W. at 10 degrees. These flags have *fucoïds* and are irregularly *ripple marked*. Hamilton rocks lie east from this and the sandy beds belonging to that group make up much of Long ridge. Dark and olive shales appear beyond Scrub Grass creek, which are well exposed on Bobb's creek at Mowry's mill. There they dip due northwest at 15 degrees, are olive, with ferruginous stains, are non-fossiliferous, but the flaggy beds show the marks of flowing mud. These shales are well exposed in the road northward from Mowry's mills to where it crosses Scrub Grass creek.

No exposures were found on this creek until beyond the mouth of the first tributary entering from the north. There fragments of the Chemung *lower conglomerate* are scattered over the hillside and many of them are fossiliferous, containing *Ambocælia* in abundance, with many *crinoid* plates. Exposures of the shales and sandstones of this part of the Chemung are shown occasionally between this and the township line. Passing into

Union township

one finds at the first tributary entering from the north thin flaggy sandstone with *Spirifera disjuncta*, *Streptorhynchus chemungensis*, *Productella* and *Ambocælia gregaria*. Here the road leading to Marietta begins to climb a high wooded ridge and thence affords no exposures until within a mile of Marietta where are good exhibitions of Chemung rocks, which continue thence northward to the Knisely school-house. There the road enters

King township

and descends Beaver Dam run, which affords no exposures

as the hills on both sides are rounded. But fragments of the *Chemung conglomerate* are plentiful in the débris of the stream, having been brought down from Blue knob, a part of the ridge made by that conglomerate, which has been followed from the Pittsburgh pike.

Long ridge, in the vicinity of this stream, has been cut down greatly by erosion and no exposures were found of either Chemung or Hamilton. The lowest beds of the latter series are poorly exposed at the foot of Pine ridge. The Oriskany is shown near the top of the ridge beyond which a cherty bed of the Lower Helderberg contains many characteristic forms. *Favosites Helderbergia*, *Caninia*, *Strophomena rhomboidalis*, *Eatonia singularis*, *Strophodonta woolworthana* were recognized in one block. Some pits were seen, which evidently had been digged in search of iron ore, but no fragments of the ore were observed. The axis of the anticlinal lies at a considerable distance east from the crest of the ridge.

Returning now to

Union Township,

to the road near Marietta, one finds exposures somewhat indefinite, but the *Chemung conglomerate* is crossed before Marietta is reached, and there one is on the Catskill beds. Going southward from that village along Bobb's creek, the Chemung conglomerate is passed at V. Stuft's house, but it is well exposed again in a ravine reaching Bobb's creek at 50 or 60 rods further down. Yellowish sandy shales were seen nearer the head of this ravine, which are filled with Chemung *fossils*. The conglomerate was followed southward until it crosses George's creek. Near J. Christ's house, it has molds of vegetable *stems* and the paste varies from light gray to yellowish-gray while the pebbles are sometimes as large as cherries.

The Savage Mountain anticlinal is crossed by Bobb's creek at a little way below Mowry's mills.

Exposures soon cease along the south fork of Bobb's creek above Marietta; practically, there are no exposures above J. Croyle's house. The Catskill rocks continue above

the stream for some distance beyond that house as the dip is very gentle, and at the last exposure they were seen still far above the stream. The Pocono is reached below the summit of the mountain and its fragments are strewn abundantly over the surface as far down as J. Hite's house. But no exposure offering any details was found.

The irregular ridge extending northward from Marietta into Blair county and lying immediately west from Blue knob is known locally as "the mountain." Only Catskill rocks were seen on this ridge as well as on the western side of Blue knob. But a deep ravine has been eroded near the southern end of Blue knob, which reaches to the *Chemung conglomerate*, so that many blocks of that rock are scattered over the surface from the ravine's mouth to very near Marietta.

CHAPTER VII.

The region between Wills mountain and Evitts-Dunning mountain.

This area, which embraces Cumberland Valley and Bedford townships, is narrow from the Maryland line to the Juniata river; but there, owing to the flattening of the Wills Mountain anticlinal and to the eastern deflection of the Evitts mountain fold, the width is much increased. The northern boundary is a ridge of Medina sandstone which unites Evitts to Dunning mountain. An irregular ridge, known as Knobbly mountain, follows the middle of the area from the Maryland line almost to the Juniata, decreasing in height northward and broken into knobs by wind and water gaps occurring at short intervals. Evitts creek drains the southern part into the Potomac; Schober's creek, tributary to the Juniata, drains the central part; while Dunning's creek, rising on the Allegheny slope, enters from the north-west and, crossing the area, enters Juniata river at the west foot of Evitts mountain.

In a general way this area may be described as a synclinal; Medina sandstone forms the slope on both Wills and Evitts mountain; Clinton shales and the shaly limestones of the Lower Helderberg are shown at the foot of each mountain, while Knobbly mountain along the synclinal is made up of Lower Helderberg limestone, Oriskany sandstone, and Hamilton shales. North from the Juniata, Medina forms the rim, except for a short distance on the west side, with bands of Clinton and Lower Helderberg inside; while, in the center, elliptical belts of Oriskany and Hamilton surround an irregular ellipse of Chemung.

From the State line northward to Bedford township the Cumberland road, which follows the western valley, lies near the junction of the Clinton with the Lower Helderberg, and the Red or Rocky ridge, marking the upper limit of the Clinton, is usually only a few rods from the road. The Clinton ore has been proved to exist everywhere along the foot of Wills mountain, but, unfortunately, few pits show anything of the bed and information respecting the ore can be gathered only from inspection of weathered fragments on the surface or from statements made by owners of the land, who in many cases are but ill-informed.

The *upper bed of fossil ore* was prospected on Mr. S. Dickens' farm at a little way north from the Bethel church or $2\frac{1}{2}$ miles from the State line. The opening is at but a few rods from the road and is so far filled up that no exposure of the ore exists. The thickness of the bed is reported to vary from 18 to 28 inches and, so far as can be determined from examination of weathered fragments, the ore is of fairly good quality, though evidently silicious. Fragments of ore belonging to the *middle* or "Frankstown" ore bed of this group occur near a fence at say 60 rods west from the prospect pit, while bits of ore evidently belonging to the *lower* or *block ore* bed were seen further west near the foot of Piney ridge—an outlier of Will's mountain which holds the white Medina.

Beyond this a close synclinal was seen in the Lower Helderberg beds; and the Clinton rocks are compressed so that the Red ridge is brought very near the first ore ridge.

Two ore ridges are distinct hence for several miles. Prospecting pits were dugged on lands belonging to J. S. Cessna and P. Hardman, but they have been filled up and no information whatever could be obtained respecting the ore. The Red ridge lies east from Mr. Hardman's house and his barn is on the first ore ridge. Between these, the limestone underlying the rocks of the Red ridge is partially exposed in a little run flowing by the house.

Thence northward almost to Centerville the Red ridge lies east from the road. The first ore ridge passes under Mr. Wentling's house and the ore is exposed near by, where as far as seen it appears to be very lean. An opening was made here by prospectors and the bed is said to be 3 feet thick. No traces of the middle or "Frankstown" bed were seen here, but fragments from the *block ore* bed occur near the foot of Piney ridge. No opening has been made to determine the value of the block bed.

A narrow synclinal was found in the Clinton on the Wentling property and it is followed by the road to within a mile of Centerville, where the anticlinal east from it is crossed and the road enters the Lower Helderberg rocks. These lying at the base of the group are shaly, drab to yellowish, some of them weathering dirty white. Many of the layers contain *Leperditia alta*.

The road lies very near the Rocky ridge at Centerville, the red rocks being exposed at the fork leading to Hartzel's mills, where they dip eastward at 16 degrees. The first ore ridge runs under Hartzel's mill and the second is at say 60 rods further west. The *upper* ore bed is said to be 14 inches thick in a pit sunk near the mill, but no exposure remains. Surface specimens, which had evidently been weathering for a long time, indicate a fairly good ore. No attempt has been made to ascertain the value of the other bed.

The road follows the upper beds of the Clinton very closely for nearly 3 miles north from Centerville, but beyond School-house No. 4 it soon passes into Lower Helderberg and thence to the township line it remains in that formation.

The *fossil ore* of the Clinton was opened on Capt. M. S.

Bortz's property several years ago at nearly 120 rods west from the crest of the Red ridge. As the dip is sharper here than at Centerville, this opening was made most probably on the *middle* ore bed, though in the absence of exposures the relations could not be determined with certainty. There is, however, a distinct ridge between this and the Rocky ridge, which holds very nearly the place of the first ore ridge. No information was obtained respecting the thickness of the bed on Capt. Bortz's place, further than that it was regarded as of workable thickness. Samples were taken from surface specimens, which were sent to Mr. A. S. McCreath, whose analysis resulted as follows:

Capt. M. S. Bortz's fossil ore.

Metallic iron,	43.825
Sulphur,	0.018
Phosphorus,	0.544
Insoluble residue,	17.410

This ore bears exposure well; large blocks lie about the surface which are sound at only an inch from the surface. The fossils are large and many of the shells, especially the *Pentamerus*, are replaced by specular ore.

The *block ore* was once opened at the foot of Piney ridge on the Hemming property, almost directly west from Capt. Bortz, but no trace of the work now remains. Fragments of brown hematite lie about the fields, but beyond the presence of the ore nothing could be ascertained.

The upper beds of the Clinton are shown in the road near the Evangelical Dutch church, while the underlying limestone is partly exposed in the road near Capt. Bortz's house. The highest rock of the group is a fine grained red sandstone, with streaks of white quartz, below which are alternating beds of red and yellow shale, with bands of greenish shale, which are spotted with white and show *fucoids*. The limestone is blue, silicious, and contains lumps of calcareous clay. The *upper ore* bed was opened on A. Smith's farm near School-house No. 4, but the pits have fallen in and nothing can be learned respecting the thickness or quality of the ore.

Further north, the rocky ridge lies at a few rods west from

the house of T. and S. Boor, the house being on the Lower Helderberg. The Clinton limestone is exposed in the valley between the Red and the ore ridge, where it dips eastward at 23 degrees. The *upper ore* bed was opened here, but the opening has been filled with débris so that the bed is no longer shown. A natural exposure on the lower part of the farm gives 14 inches as the thickness. The ore is somewhat silicious but otherwise it appears to be of very fair quality. Fragments of brown hematite occur near the foot of Piney ridge on this farm, and at the foot of the ridge is a strong chalybeate spring which has formed a considerable deposit of *bog ore*. This ore has never been opened. Piney ridge shows the white Medina which is covered with *Arthrophy-cus harlani*. This rock is found also on the east slope of Wills mountain and is present up to within a short distance of its crest. Exposures are scanty on Piney ridge, which is covered with a dense forest, so that the structure cannot be made out very satisfactorily. It is probable that the ridge marks the course of a subordinate anticlinal following the slope of the ridge.

From this place the road lies near the top of the shaly beds of the Lower Helderberg, while the Rocky ridge is at a considerable distance west from it. Piney ridge, which attains its greatest height immediately north from Center-ville, decreases northward until on the D. Miller farm, two miles north from the Boor farm, it is no higher than the second ore ridge. As it loses importance the slope of Wills mountain extends eastward and the valley becomes narrow.

D. Miller's house is on the eastern slope of the first ore ridge, where a few fragments of ore were seen. Some years ago, a prospecting pit was sunk on the second ore ridge, but, like all the others thus far noticed, it has been filled. No information whatever was obtained respecting the ore, excepting from inspection of fragments lying on the surface around the pits. These indicate much variation in quality, some being very good while other pieces are very inferior. Fragments of brown hematite belonging to the *block ore* bed were seen at nearly 40 rods west from this ridge.

Northward from D. Miller's the road approaches the Red

or Rocky ridge and at last touches it near the Union church. There, however, it leaves it again and soon passes into

Bedford township

at barely 3 miles north from Miller's house. The shales at the bottom of the Lower Helderberg contain some thin beds of blue limestone, from one of which, near J. Wertz' house, *Leperditia alta* was obtained. Thence to the Pittsburgh pike the Red ridge is only a few rods west from the road, and the ore has been prospected on farms belonging to J. Strominger, the County Home, and W. Dunkle. The pit on the County Farm, though like the others—no longer showing the ore in place—has much ore lying on the old dump. The bed is said to be 14 inches thick. Fragments of ore lying on the dump show it to be soft, fine grained with specks of specular ore and grains of decomposed shale. The shale overlying the ore is ferriferous and very fossiliferous; *Spirifera*, *Strophomena*, *Orthis*, *Rhynchonella*, *Streptorhynchus* and *Dalmania* were seen. Samples of this ore were taken which were forwarded to Mr. A. S. McCreath for analysis. The composition is as follows:

Fossil ore from the County Farm.

Metallic iron,	44.400
Sulphur,	0.017
Phosphorus,	0.161
Insoluble residue,	22.270

A sharp narrow anticlinal lies very near the road here and shows dips of 50 degrees eastward and 60 degrees westward. The dip at a quarry on the County Farm, west from the anticlinal, is eastward or south-south-east at 35 degrees.

This limestone, which is near the bottom of the Lower Helderberg, is impure, but it has been burned into lime for agricultural purposes. An exposure near Mr. Gephart's house, shows an eastward dip of only 20 degrees and is on the east slope of the anticlinal. Piney ridge re-appears before the Pittsburgh pike is reached.

The Clinton rocks are reached on the Pittsburgh pike at the second house east from the fair-ground, where they dip south-eastward at 65 degrees. No further exposure appears

until at Sproat's house a shallow cut exhibits contorted shale dipping eastward at from 15 to 65 degrees, while at the end of the cut it is turned up abruptly and pushed over so as to dip westward at 78 degrees. The *upper ore* bed is shown imperfectly at 25 feet further and the shales immediately beyond it have an eastward dip of 50 degrees. This rate of dip decreases quickly as one approaches the fair-ground, where it is barely 20 degrees S. 55° E. The extensive stripplings and tunnelings, by which the ore was mined for the Kemble Coal and Iron Company, begin opposite the fair-ground. They are rudely parallel, but the strike changes as the Wills Mountain axis diminishes in strength, so that while the dip is at first south-east, it soon becomes only 20 degrees south of east. The stripplings, practically eight in number, are all on the same bed, which is brought to the surface again and again by a series of narrow anticlinals.

The first stripping shows an irregular south-east dip of 70, 10 and 25 degrees; the next, 60 feet further north-west, shows a synclinal in yellow shales with north-west dip on east side of 35 degrees and a south-east dip of 42 degrees on the west side. The width of the synclinal is not much more than 40 feet; for in the next stripping, 81 feet further north-west, the same fissile yellow shales are dipping N. 30° W. at 50 degrees, and they are rich in *fossils*. The next stripping is nearly 800 feet distant from the last, but an intervening exposure on the pike shows an anticlinal with a dip of 34 degrees, N. 25° W. on its western side.

The fourth stripping reaches almost to the pike. The dip is 40 degrees, but towards N. 65° W. which shows that there is a decided bend in the strike. The ore is not exposed, but the same yellow fissile shale is present.

The fifth stripping, at 57 feet further, is small and shows an anticlinal, so that a shallow synclinal passes between this and the last, like nearly all the petty anticlinals, this has a decided pinch at the crest with abrupt sharpening of dip. Away from the crest, the dips are 25 degrees eastward and 30 degrees westward. The dip in the sixth stripping, 96 feet beyond, is somewhat complicated, being 50 degrees west at west end, then almost horizontal, then showing a

double fold within 8 feet, and ending with a dip of 85 degrees toward S. 70° E.

The seventh is 147 feet further west; yellow shales dip almost due east on eastern side, but the dip quickly falls to 10 degrees and then changes to 49 degrees westward. A tunnel was driven to the ore lower down the hill.

The eighth working is at but a few rods further west and extends from the last anticlinal to beyond the next. Two tunnels have been driven here and a narrow stripping has been made beyond the second. The whole exposure is about 75 feet long. Two folds with complicated dips are shown here, the easterly dips varying from 15 to 65 degrees and the westerly dips from 15 to 45 degrees. This is the last of the workings; it begins at a little way south from the Colored school-house and continues northward almost to the Juniata river. The work has been abandoned and much of the ground has been exhausted. Little ore remains on the dump, but such as was seen is clearly of excellent quality.

A bark road, which leaves the pike at the fair ground and ascends Will's mountain, affords imperfect exposures of the shales for say 100 rods. These indicate the crumplings seen in the ore pits, but afford no details. The white or upper sandstone of the Medina is shown in a bluff at say 300 rods from the point where the road leaves the pike; but the dip of the rock could not be ascertained satisfactorily, as the exposed surface is badly weathered. This ridge, separated from the rapidly decreasing mountain, is due to an anticlinal which is probably a continuation of the Piney ridge of Cumberland Valley township and crosses the pike at say 100 rods from Mr. Kennedy's house, where a road cutting shows the upper bed of the Medina. But on the ridge the Medina is not exposed until the slope of Will's mountain is reached.

The west side of this Piney ridge anticlinal is reached on the pike at the curve beyond J. S. Kennedy's house, where the sandstone dips westward at 35 degrees and has yellowish shale overlying it. The Clinton shales are shown again west from the road near J. Hafer's house. An anticlinal

passes not far from D. R. Smith's house, and it is indicated also on the pike near the Juniata bridge. The *block ore* is not shown in the road beyond Mr. Kennedy's house, but its existence is probable near Mr. Smith's house. At 50 rods west from his house, or 125 rods from the pike, the upper part of the Medina has been explored for ore. The rock, which dips westwardly at 43 degrees, contains many films of *limonite*, but the quantity is too small to be of economic value.

The same sandstone is shown in the pike at the last house before reaching the Juniata bridge, where its dip is almost due east at 23 degrees, the eastern slope of the axis passing near D. R. Smith's house. The white Medina forms the walls of the gap by which the Juniata crosses the northern end of Will's mountain. The northern termination of the Medina of Will's mountain is very near the pike at the first house beyond Wolfsburg. The dip is very gentle north-eastward at the Clinton exposure in the road.

The Kemble Coal and Iron Company have continued the mining of *fossil ore* along the line of outcrop north from the Juniata river, where a system of foldings similar to that already described, seems to prevail. The following is the section of the beds on the Pierson property :

Pierson fossil ore bed.

Ore,	1' 2" to 0' 8"
Shale,	1' 0" to 0' 6"
Sandstone, blue,	2' 6" to 2' 0"
Ore,	1' 6" to 0' 8"
Shale,	1' 6"
Ore,	0' 4"

The average thickness of the top bed is not far from 10 inches and it yields a bright clean ore, very soft and much prized. The middle bed varies greatly, often being cut out altogether by thickening of the overlying sandstone. The lowest bed is seldom thick enough to repay working. Samples of the ore were taken from these mines and sent to Mr. A. S. McCreath, who reports the following as the composition :

Kemble C. & I Co.'s ore, Wolfsburg.

Metallic iron,	46.450
Sulphur,	0.011
Phosphorus,	0.344
Carbonate of lime,	11.607
Carbonate of magnesia,	1.136
Insoluble residue,	12.770

The shales accompanying the ore are very fossiliferous, the following forms having been recognized during a hasty examination :

Caninia ; *Spirifera niagarensis*, *Strophomena rhomboidalis*, *Streptorhynchus subplana*, *Rhynchonella neglecta*, *Orthis elegantula*, *Trematospira aprinis*, *Aviculopecten*? *Bellerophon*, *Dalmania*, *Limulurus*, and *Bumastis barriensis*. The dip is very gentle and the sandstone associated with the ore dips north-eastward at only 9 degrees.

Knobbly mountain is persistent south from the Juniata river, but much broken by small streams ; it attains its greatest importance south from the State line ; but within Cumberland Valley township it is merely a succession of knobs rising 300 to 500 feet above the adjacent valleys. It is broken by water gaps five times in Cumberland Valley township and once in Bedford township. The ridge is composed of Lower Helderberg and Oriskany ; but for the most part the Hamilton beds have been cut down to form the valleys of Evitts' and Schober's creeks.

Exposures are rarely good in the gaps, and elsewhere debris or forest growth effectually conceal the details. Perhaps the least unsatisfactory exposure in Cumberland Valley occurs along the road leading from the new Bethel church, at two miles and a half from the State line, eastward to Growdon's mill on Evitt's creek. The shaly argillaceous limestones of the Lower Helderberg, are seen soon after leaving the church ; they have a reddish tinge on the fresh surface, weather yellowish-white, and contain *Leperditia alta*. Where the road turns northward, they are succeeded by the blue flaggy beds of the group, whose layers are from half inch to an inch and a half thick ; while the more compact beds are reached where the road turns eastward at say 30 rods west from J. W. Deffibaugh's house. The dip at

the Cumberland road is 25 degrees eastward. A narrow anticlinal passes at a little way east from that road; and thence the dip diminishes so that when the blue limestone is reached the rate is somewhat less than 15 degrees. One of the compact limestones is quarried and burned for agricultural purposes by Mr. Deffibaugh.

The dip quickens east from Mr. Deffibaugh's, so that where the Oriskany comes down at the spring, 40 rods further, it is dipping at 55 degrees. Here the Hamilton shales are reached, and one enters a valley eroded by a tributary to Evitt's creek which rises at the foot of Wills mountain nearly a mile south from Centerville. The shales are shown occasionally in this valley, and continue until within two or three rods of the Methodist church on Evitt's creek, where the Oriskany again comes up with a sharp westward dip; but the exposure does not give the rate well. The syndi-nal is at less than one sixth of a mile west from the church.

The Lower Helderberg is brought up near Growdon's mill, where it is quarried and burned for agricultural purposes. But the creek follows an anticlinal here, so that the exposure of Lower Helderberg is but a narrow strip along the stream. Oriskany occurs again on the east side of Evitt's creek, where it dips eastward—this being the anticlinal following the foot of Evitt's mountain. Oriskany is the surface rock northward from Growdon's mill until nearly two miles south from Zembower's mill, where the cherty transition rock is shown in the road. Thus far the area of Oriskany is comparatively broad, owing to the eastward bend of Evitt's creek; but within a mile of Zembower's mill the course of the stream is changed so that thence it flows from the north-west and the area quickly narrows, that of the Lower Helderberg widening at its expense.

Thus far the exposure of Clinton rocks has been imperfect. Débris from the Medina of Evitt's mountain covers the whole bench occupied by that group; but the presence of the *fossil ores* is proved by scattered fragments. No exploration has been made to ascertain the value of the beds.

Exposures are wholly wanting on the road leading across Evitt's mountain from Zembower's mill to Bean's cove. The

anticlinal already referred to carries the Lower Helderberg well east toward the mountain, and that group runs out only in the ridge behind Mr. S. Hendrickson's house. No traces of Clinton rocks were seen, all being covered with Medina débris. Many blocks of the white Medina were seen, drilled as if by *Scolithus*. The rock is shown in place near the crest of the mountain, where it dips westward at 40 degrees.

A decided change in conditions takes place at about a mile further north; the red or lower Medina is at the crest of the mountain, and the dip increases rapidly, so that where the road from Rainsburg to Centerville crosses the mountain the white Medina lies west from the summit and is dipping eastward at from 70 to 80 degrees. The lower beds of this are snow white, but some of the upper beds are reddish and slightly ferruginous. *Arthropycus* is plentiful throughout. The Clinton beds are ill-exposed. No traces of the *block* ore were seen, and only a few fragments of the *fossil* ore were found. The upper bed of the fossil ore is said to have been opened on the Wertz estate, nearly a mile south from this road, but the diggings have disappeared.

Fragments of Lower Helderberg limestone were first seen at about 60 rods below T. Rose's house, and the more compact beds of that group form a bold ridge immediately beyond the first crossing of the run. No beds are shown in place, but fragments of the limestone are numerous until just beyond G. Nave's house, where fragments of Oriskany sandstone first appear.

At the fork of the road below G. Nave's house one is in the open valley eroded in Hamilton shales, but there are no exposures. On the road leading northward, a quarry in Lower Helderberg was seen just below Jacob Miller's house, where the beds dip gently eastward; but within a few yards they become vertical and then rise rapidly eastward. On the run, above this, the Oriskany sandstone is reached at the forks of the road below the house formerly belonging to R. Deremer; and within a few rods, or near J. McFerran's house, one comes to the Hamilton shale; but there are no satisfactory exposures. Knobbly mountain is bold on the west side of this valley, and the Lower Helderberg crops out

at several places along its western slope, at one of which it is quarried by the Boor Brothers and burned for agricultural purposes.

Still following the road one soon comes to Schober's creek and crosses it at barely half a mile below Hope Methodist church. The valley now becomes wide and the distinction of ridges on the east side is practically lost from this point to the township line, as the slope is almost regular from the creek to the base of the white Medina bluff. The only road lies on the west side of Schober's creek and follows closely the line between Oriskany and Marcellus shale, the latter being shown almost immediately east from the road, while the former covers the ridge at the west. The Lower Helderberg reaches to this road at Arnold's saw-mill, where it is dipping eastward at 30 degrees. Great fragments of Oriskany have rolled down to the road north from Arnold's mill, and most of them are rich in *fossil impressions*; but good specimens cannot be obtained, as the shells have been leached out and only interior casts remain, which are too tender to be removed or transported. Within a mile and a half north from Arnold's mill one comes into

Bedford township,

where for more than a mile the conditions show no change. Oriskany forms the east slope of Knobbly ridge, while Hamilton shales are occasionally exposed on the east side toward Schober's creek. Soon after entering Bedford township, the conditions along the west slope of Evitt's mountain show some change and the Lower Helderberg ridge becomes distinct from the Clinton bench, while, as before, the white Medina sandstone forms a bluff near the crest of the mountain. The *fossil ore* was prospected on the Schaeffer property some years ago, near the road leading across the mountain from Bedford Springs; but the pits are filled. Prof. J. P. Kimball informs me that he measured

Soft ore,	3'
Hard ore,	0' 10"

in one of the pits on this property, when the openings were made.

As the Schober's Creek road approaches Bedford Springs it crosses the synclinal, so that at the Springs it is in the Lower Helderberg of the east side. Exposures are indefinite for a little way south from the Springs, but the Oriskany seems to pass very near the hotel. That rock on the west side of the synclinal is very well shown at several places south from the springs and at all it is richly fossiliferous; *Spirifera arenosa*, *Spirifera arrecta*, *Spirifera cumberlandiae*, *Merista lata*, *Streptorhynchus hipparionyx*, *Megambonia*, *Platyceras*, *Platyostoma ventricosum* were seen abundantly, though not in good condition of preservation. The upper part of the mass is gray, stained with brown near the surface and weathers to very light gray.

The massive beds of the Lower Helderberg are shown in the precipitous bluffs behind the Springs hotel, and the blue flaggy limestone is reached within a few rods, whence it continues into Bedford; a double anticlinal is shown as the road turns into the borough just beyond the Arandale hotel, and there the blue flaggy limestone contains *Beyrichia*, *Spirorbis*, *Leperditia*, *Spirifera vanuxemi* with *Megambonia aviculoidea*. The Oriskany ends at a little way south from the Arandale hotel, where it runs out on the hilltop.

The lane leading south-westward from Bedford past Judge Hall's house does not reach Oriskany for fully half a mile south from that house, while on Knobbly mountain the Oriskany is not reached for a greater distance. The Oriskany and Hamilton run out, therefore, at but a little way north from Bedford Springs. Their disappearance is due no doubt to the appearance of the several petty anticlinals observed within the borough of Bedford.

Brown hematite was obtained at the Bedford reservoir in the Lower Helderberg limestone and much that was taken during excavating for the reservoir still lies piled up there. It is, however, silicious and of inferior quality.

The limestones are fairly well exposed on the ridge behind Judge Hall's house and the following measurements were made in passing over that ridge to the Cumberland road at Mr. Gephart's house:

No. VI at Bedford.

1. Limestone, not seen in detail,	estimated,	80'
2. Limestone, coarse, light gray, with <i>crinoid</i> stems; dip 27 deg. S. 75° E.,		5'
3. Limestone, compact, dull gray, cherty, fossils small, and indistinct,		15'
4. Limestone, reddish gray, compact, with conchoidal fracture,		3'
5. Limestone, compact, gray, silicious and cherty; contains <i>Canina</i> , <i>Syringopora</i> ? <i>Stromatopora</i> , <i>crinoid</i> stems,		7'
6. Limestone, bluish gray, more or less slaty, fossils few and small,		5'
7. Gray limestone,		12'
8. Limestone, sandy at top, becomes more calcareous near middle and is compact, fairly good limestone below; in middle a thin layer occurs, which is crowded with <i>Leptocoela imbricata</i> . This mass can be followed to Bedford, where it is well exposed under the African church as well as on the second street west from the courthouse. Dip 25 deg. S. 70° E.,		50'
9. Concealed,		12'
10. Limestone, gray, semi-crystalline,		2'
11. Concealed to foot of hill, allowance being made for dip,		270'
12. Concealed in bottom to western outcrop horizontal distance of 615 feet with dip of 25 deg.,		260'

A sharp synclinal was seen in Bedford borough at the corner of Pitt and Juliana streets. The dip on the east side is 45 degrees almost due west; that on the other side could not be ascertained satisfactorily. Limestone alone was seen at all exposures within the borough. The limestone No. 8 of the section last given is quarried and burned on the hill beyond the African church, but the rock is inferior and needs to be selected with much care.

No exposures were seen along the Bedford and Chambersburg pike east from the borough, aside from one of the Lower Helderberg, where a road crosses the river. The *fossil ore* was mined at one time at the foot of Evitts' mountain near Dunning's narrows, but the tunnel has been abandoned.

The area north from Juniata river.

At the head of the gap through Evitts' mountain, known as Dunning's narrows, the Medina sandstone is exposed

alongside of the pike where the dip is 85 degrees eastward. The rock is milky white, and bears many patches of dark brown lichens. The top of the mass is concealed by débris. The whole exposure is not far from 170 feet. *Brown hematite*, belonging to the *block* ore bed, occurs in large quantity at the roadside and amid the Medina débris well up the hillside. The exact position of the bed has not been ascertained.

Everything is concealed from this to the Weaverling tunnel in the *fossil ore*, which adjoins a tunnel formerly worked by the Kemble Coal and Iron Company. Both of these have been abandoned. The section in the Weaverling tunnel is reported to be

Weaverling tunnel fossil ore bed.

Ore,	1' 11"
Sandstone,	2' 6"
Ore,	1' 6"

the thickness of ore being the extreme in each bed ; for the whole section rarely exceeds 5 feet. Some ore was seen on the dump of this tunnel, which is fairly good but evidently silicious. The yellow shales associated with the ore are fossiliferous ; *Dalmania limulurus*, *Streptorhynchus subplana* and *Rhynchonella neglecta* being abundant. Mr. Franklin Platt obtained the following section in the Kemble company's tunnel, while it was worked in 1872 :

Kemble Co.'s fossil ore bed.

Ore,	1' 5" to 1' 0"
Sandstone,	2' 6" to 1' 1"
Ore,	1' 4" to 0' 4"
Sandstone,	2' 4" to 2' 0"
Ore,	1' 8" to 0' 6"

This is a combination of two sections obtained in the tunnel at 75 yards apart. The ore is good, but the soft sandstone and shale between the beds being easily removed with the pick offered too great temptation to the miners, who mixed them with the ore. This difficulty proved too great to be overcome and the Kemble Company was compelled to abandon the tunnel.

On the road which lies along the foot of Evitt's mountain the first exposure of Oriskany is reached at the forks immediately beyond J. Shaffer's house; and the Lower Helderberg is shown at a few yards further, where it dips north-westwardly at 38 to 40 degrees. Here the Medina outcrop bends sharply toward the north-east and the dip of rocks along the road diminishes, so that after passing Mr. Diehl's house it is but 12 degrees. The Red ridge of the Clinton lies at from 40 to 50 rods east from the road. Fragments of the ore lie scattered over the surface between the ridge and the foot of the mountain; but the covering of débris is thick and no exposures were found in place. The ore was once prospected on Mr. Fetter's place, formerly belonging to J. Croyle, where the *upper bed* was found to be 16 inches thick. No search was made for the lower bed. The road passes near the crest of a compressed anticlinal near J. Croyle's and just before reaching the fork south from Adriel Koontz's house, the dip is N. 55° W. at 25 degrees. Thence the rate diminishes.

A prospecting pit was dug on Adriel Koontz's property by Mr. Zimmerman for Robert Hare Powel. The pit has been filled up, but Mr. Zimmerman gives the section as follows:

A. Koontz's fossil ore pit.

Ore,	.....	2'
Shale,	.....	1'
Ore,	.....	0' 2"

The pit is 76 feet deep and the dip is almost vertical; the ore is a mixture of fossil and brown hematite.

Near Dibert's saw-mill the outcrop lines bend sharply westward and thence for some distance the Red ridge lies near to the road. Exposures become very imperfect beyond the saw-mill; but one just beyond John Dibert's house shows a dip of 15 degrees almost due south. The Lower Helderberg limestone dips S. 80° W. at 30 degrees at the fork of the road by Dibert school-house. Thus far, the road has been wholly in the Lower Helderberg, but the edge of the Clinton group is crossed at the summit of the hill before reaching J. D. Felter's house and thence almost to G. Bid-

dle's house one rides on the Clinton shales. Ore has been taken from the *upper bed* on Mr. Felter's place.

The Lower Helderberg is reached again at the bend of the road east from G. Biddle's house; thence to G. Reighart's house the Red ridge lies very close to the road; but there the ridge and road diverge and the Clinton rocks are not reached again until one comes to Heltzel's house beyond the school-house. There the red beds are crossed at the barn, and the Clinton limestones are fairly well shown in the road beyond.

The *fossil ore* was prospected for Robert Hare Powel on John Schnably's farm. The pit is filled, but Mr. Zimmerman gives the following as the section obtained by him:

J. Schnably's fossil ore pit.

Ore,	1' 10"
Shale,	1' 0"
Ore,	0' 2"
Shale,	2' 0"
Ore,	0' 4"

The shale between the *lower* and the *middle* beds contains some sandy limestone. The ore is both hard and soft, and according to Zimmerman there appears to be no regularity in the occurrence of the two conditions. The *block ore* exists near D. Felter's house, half a mile west from Schnably's, but no attempt has been made to ascertain its value.

Following this road to the township line, one rides constantly in Clinton shales, the Medina of Dunning's mountain ending north from this road.

Turning southward at the township line, one finds the Clinton shales well shown on the hill north from D. Walters' house, where the dip is S. 20° E. at 6 degrees. The *fossil ore* was mined on this as well as on the Holderbaum property adjoining, but the operations were stopped by the panic of 1873. Mr. Franklin Platt obtained the following section on the D. Walters' farm in 1872:

D. Walter's fossil ore mine.

Ore,	2' 4''
Shale,	4' 0''
Ore,	0' 9''
Green slate,	0' 4''
Sandstone,	0' 11''
Ore,	1' 2''

The dip is approximately 4 degrees, S. 70° E. The ore lies very near the surface on this property and the dip is gentle, so that much can be mined by stripping.

The Kemble Coal and Iron Company were mining about 30 tons of ore each day, when the adjoining property of Jacob Walters was examined. For a long time the mining was done by strippings, but the cover now exceeds 12 feet and the mining is done by drifts. The section as imperfectly shown in a stripping near the mouth of the tunnel is

Jac. Walter's fossil ore mine.

Ore bed,	3' 0''
Shale,	3' 0''
Ore bed,	0 4'' to 0' 2''
Shale,	1' 0''
Calcareous sandstone,	1' 6''
Ore,	0' 7''

Only the *upper* bed is mined, and the dip in the tunnel is approximately 4 degrees. The ore of the upper bed averages nearly 2 feet, the remainder of the bed consisting of ferruginous shale at the top, 6 inches thick, and a hard sandstone of similar thickness at the bottom. The shale shows little variation in thickness, increasing only near some of the slight faults. The ore is somewhat variable and generally needs selection before shipment. It is soft at the outcrop, but after passing under solid cover quickly becomes hard. Blotches of specular ore are numerous, and occasionally a block of very excellent *red hematite* occurs, soft enough and pure enough for paint stone. The fossils are well preserved and among them were seen *Spirifera niagarensis*, *Streptorhynchus subplanus*, *Rhynchonella*, and *Favosites*. The lower bed contains hard fossil ore, of fair quality, but is too thin to be mined with profit. Samples were taken

from the upper bed, which were sent to Mr. A. S. McCreath, who reports the following composition:

Metallic iron,	25.725
Sulphur,	0.034
Phosphorus,	0.251
Insoluble residue,	9.020
Carbonate of lime,	46.339
Carbonate of magnesia,	2.648

A shaft on this property, now closed, showed a different arrangement of the ore, for in 1872, it yielded the following section to Mr. Franklin Platt:

Jac. Walter's fossil ore shaft.

Surface,	1' 0"
Ore,	1' 1"
Red shale,	1' 0"
Sandstone,	1' 6"
Ore,	0' 4"
Sandstone,	1' 6"
Slate,	2' 0"
Ore,	0' 4"
Slate,	0' 2"
Ore,	0' 11"
Slate,	0' 6"
Shale,	0' 6'
Slate,	1' 0"
Ore,	1' 0"

and the dip is 5 degrees southward.

The axis of the Wills-Dunning anticlinal passes through Jacob Walter's property; so that, by driving tunnels on each side, the ore can be mined by natural drainage. Slips of one foot, however, occur and interfere somewhat with drainage. The shales continue to the township line at the west and the gentle westward dip is distinct beyond Mr. Walters' house. The Clinton rocks extend southward without interruption beyond Dunning's creek, but the extent of the ore beds has not been determined by exploration.

Entering the township from the west by the road leading from St. Clairsville to Bedford one finds himself still in Lower Helberberg. The slaty limestones of that group are dipping almost due west at 20 degrees, and the higher massive beds are quarried for lime in the field near the Reformed church. The westerly dip continues until within a few

rods of Bush run, where the Clinton rocks are reached again with a westerly dip of only 2 or 3 degrees. These rocks extend along Bush run and are fairly well exposed near its mouth. From this run to a short distance beyond the Methodist church, the Clinton rocks are occasionally exposed, and the dip at the blacksmith-shop beyond the church is S. 82° E. at 10 degrees. An exposure of the shaly limestone north from the church shows an easterly dip so small that it cannot be measured with the ordinary clinometer. This limestone is gray, weathers drab and contains great numbers of *Leperditia alta*. A dark limestone containing the same crustacean, with other forms, was seen at the cross-roads.

For the rest of the way the road lies in Lower Helderberg; and near Bedford the massive beds are exposed in the hill alongside the road. The dip at the Bedford cemetery is N. 55° E. at 15 degrees, but as the road approaches the railroad the dip decreases to barely 8 degrees. The rock is bluish to flesh colored and contains *Spirifera*, *Rhynchonella* and *Trematospira*. At a few yards from the St. Clairsville road the dip is eastward at 30 degrees, while at 40 yards further it is westward at 55 degrees. This is the synclinal which was seen in Bedford borough at the corner of Pitt and Juliana streets.

A road leaves the St. Clairsville and Bedford pike at a little way north from the cemetery, and lies in the Lower Helderberg until within a very little distance from Mr. W. Felter's house, where the Oriskany is reached; within a few rods the Marcellus shales are shown in the road. Thence to Dunnings creek, only these shales are shown. But the Oriskany is at only a few rods away toward the west; for, at Hughes' house near Dunnings creek, that rock is shown at the roadside. The *brown hematite of the Oriskany* occurs here, and at some places the quantity is considerable. It was mined at one time in a small way on the Hughes and Henderson properties. Above Hughes on Dunnings creek, the road lies in Lower Helderberg until it crosses the creek, where it comes to the Clinton area near the mouth of Bush run.

There are few exposures for some distance north from Dunnings creek, but the road certainly passes beyond the Clinton soon after crossing the creek, and thence to the fork at A. Samuel's place it is in the Lower Helderberg. A very close anticlinal was seen at Mr. Samuel's house.

Leaving this road at the Lutheran church north from the creek, and going eastward one finds, on the hill opposite the church, the Lower Helderberg limestone dipping S. 55° E. at 15 degrees; while near the summit of the ridge, which is practically a continuation of Knobbly mountain, the dip is S. 45° E. at 20 degrees; and the limestone contains *Spirifera perlamellosa*, *Spirifera cycloptera*, *Pentamerus pseudogaleatus*, *Orthis* and *Bryozoans*.

The Oriskany is reached at the summit of this ridge on the road to Imlertown, but the rock is not exposed in place and its presence is indicated only by the fragments. No exposures occur until the first fork in the road is reached, where the Marcellus shales are shown. Oriskany is reached again at the Evangelical church, where the black shales rest on it; and it is wholly passed at a little way northward just beyond Bailey's mill, for there the Lower Helderberg is in the road. Turning southward at the mill one soon comes again to the sandstone, and thence to Mr. Stiffler's the road lies in that rock. But at that house the road leaves it, and thence to the Lutheran Church lies in the Marcellus. The shales dip sharply north-westward at the forks near Mr. Beegle's house, and the Oriskany is at only a few rods east from the house.

The Oriskany lies very near the road south from Mr. Beegle's house; and at the Lutheran Church the sandstone is in the road. Thence to the crossing at J. W. Lingenfelter's the shales cross to the east side of the road at but two or at most three places. The dip of the sandstone is westward at barely 8 degrees. The *Oriskany ore* is shown at about 80 rods north from Lingenfelter's, where it is very sandy.

Turning westward at Lingenfelter's, one finds himself in the Hamilton rocks, which continue until Dunning's creek is approached, where the flags of the Lower Chemung form

a ridge. The same rocks are shown with gentle dip on the west side of the creek, where also they form a ridge. Hamilton beds are reached on the west side of the synclinal near Mrs. Yount's house and the Marcellus shales are shown at the fork of the road near the Schnably school-house.

Returning to Dunning's creek and following the road leading down that stream, one rides in Chemung rocks to where the road leaves the creek at a little way below Mr. Phillips' house. The Hamilton beds are reached within a few yards and the Oriskany is shown at the Race grounds by the Chalybeate spring. The Lower Helderberg is exposed at the hotel; and thence to Bedford borough the exposures of that group are continuous on the railroad, in the river, or on the road following the north side of the river.

CHAPTER VIII.

The region between Evitts-Dunning and Tussey mountains.

This embraces that part of Southampton township known as Bean's Cove the whole of Colerain and Snake Spring townships, forming Friend's Cove; and the townships of South Woodberry, Woodberry, and Bloomfield, which form a portion of Morrison's Cove.

As Tussey and Evitts Mountains are both anticlinals to near the northern boundary of Bean's Cove, they show only the Upper Silurian rocks. Martin's Ridge follows the middle line of the Cove from the Maryland line to near the head of the valley, where it is cut off by the gap of the Flintstone creek; but it soon begins again, to end abruptly in Martin's hill at a few rods north from the township line. In the southern part of the Cove, this ridge is made up of Lower Helderberg limestones, with a narrow streak of Oriskany following the crest; but the sandstone runs out before reaching the Flintstone gap, owing to the general upraising of the whole series northward. The Clinton rocks are on both sides of

the valley, while Medina sandstone is shown on each mountain near its summit.

Entering the cove from the west by the Centreville road one finds Medina sandstone forming the slope of the mountain and dipping east at somewhat more than 32 degrees. The hard sandstone stands out in the road in low parallel cones, which make the passage difficult even for one on horseback; and the transition to the Clinton is well marked by the change in character of the road. The Clinton occupies a distinct bench, which is continuous along the foot of the mountain to beyond the State line. The shaly beds of the Lower Helderberg are first reached at the Walnut Grove school-house.

Turning southward, the Red ridge, marking the summit of the Clinton, is almost directly alongside of the road, and though occasionally somewhat obscured by erosion, it is easily followed to the Maryland line. It is broken here and there by gaps, made by petty streams, above which it seldom rises more than 80 or 100 feet. Immediately behind it toward the mountain is an equally well-marked ore ridge, which for nearly the whole distance between the forks of Flintstone and the Maryland line shows fragments of the Clinton ore. This ore, which was examined on several properties, changes rapidly from *fossil* to *brown hematite*, both forms being found within short distances and sometimes in the same block. Samples were taken from the property of Hon. William Donahue, but by some mishap, they have disappeared.

The only road crossing Martin's ridge leaves the Cumberland road at about a mile from the State line and leads to a point on Flintstone creek about one fourth of a mile from the same line. Few exposures were found on this road until near the summit, where fragments of limestone with those of Oriskany sandstone cover the ground. Oriskany is reached at a little way west from the summit, and Lower Helderberg forms the crest. The synclinal is evidently very close, but the exposures give no exact information respecting the rate of dip. A dark gray limestone on the east side of the ridge is rich in fossils, *Atrypa reticularis*, *Spirifera*

cycloptera, *Strophomena rhomboidalis*, *Chaetetes*, *Favosites*, *Caninia* and *Orthis* having been observed during the hurried examination. The cherty transition bed at the top of the Lower Helderberg is very near the crest of the ridge, where its fragments are abundant. It is rich in *corallines*.

Few exposures were seen beyond the summit until very near J. Wigfield's house, where the shaly beds of the Lower Helderberg describe a close and somewhat complicated anticlinal. The Clinton rocks are shown at barely 30 rods further east, where they dip almost west at 15 degrees. The ore ridge is distinct further on and shows a white sandstone. The dip is very gentle to beyond the creek, being only 3 degrees at the most eastern exposure found. A broad "bottom" has been eroded by the creek in which everything is concealed.

Following the creek northward one finds the upper bed of the Medina before reaching School-house No. 1, where it forms a precipitous bluff and dips westward at 40 degrees. The valley of Flintstone is very narrow here and the hill on the west side rises abruptly, showing the Lower Helderberg limestones as well as part of the Clinton. From the School-house to within a few rods of Perdew's mill the road lies between the ore ridge and the Red ridge, the latter being very distinct where crossed below the mill.

The outcrops of the Lower Helderberg are 325 rods apart at the State line; but thence northward they approach gradually, until at the forks of the creek the space is but 260 rods. The limestones of the middle and upper parts of this group are quarried and burned for agricultural purposes. The lime is rather dark, but is strong and answers well for building purposes.

Following the road which leads across Tussey mountain to Chaneyville one reaches the Red ridge again very near the house of L. and S. Casteel, and at a little way further evidences are very clear that the *fossil ore* is present. The Clinton makes a broad bench on this side of the valley, but no exposure were found which give the group in detail. The Medina is reached as one approaches the summit, where the dip is westward at nearly 40 degrees. But the expos-

ures on this mountain are far from so satisfactory as those on Evitts mountain. Further south the dip appears to be much steeper.

Martin's ridge begins again immediately north from the forks of Flintstone and quickly becomes a bold ridge, known as Martin's hill, which stretches from one mountain to the other and closes the Cove at the north. It is covered by a dense forest and an almost impenetrable undergrowth, while the coating of débris is thick and effectually conceals the bedded rocks. It was not found feasible to trace out the limits of the Lower Helderberg or Clinton on this hill. But the northward rise is very rapid, the basin becomes very shallow, and these groups pass into the air before reaching the northern limit of this township. The white Medina near the mountains becomes gentler in dip northward until on both sides the rock loses continuity along the crests and the lower Medina is exposed. The upper Medina, rises northward in the cove until just beyond the township line it passes into the air and forms a bold wall on the top of Martin's hill, said to be the highest point in Bedford county.

No road crosses Martin's hill and the trails made by cattle and hunters are very obscure, so that in order to reach

Friend's Cove,

which embraces Colerain and Snake Spring townships, one must cross and re-cross either Evitts' or Tussey mountain and enter the Cove from either Cumberland Valley or Monroe township. Entering by way of Neil's gap from Monroe township, one finds himself at once amid the shales and sandstones of the lower Medina, for the upper Medina, forming the crest of Tussey, lies here wholly within Monroe township. Tussey is monoclinal, the rocks dipping eastward. As one goes from the township line westward to the summit of the gap he finds the dip becoming complicated. Beyond the summit, many partial exposures were seen in side cuttings, but usually they appear to belong to rocks which had slipped out of place. The prevailing dips are southward or south-eastward. Emerging from the long gap one is in a broad valley deeply covered with alluvium and

rarely affording any exposures. The lower Medina rocks form a well marked ridge south from the gap, whose slope curves westward and joins that of the bold promontory which forms the northern end of Martin's hill and terminates at barely a mile south-west from the borough of Rainsburg.

The Utica shales are reached at Rainsburg, while immediately beyond that borough the upper part of the great Lower Silurian limestone is reached in Spring Mountain run, a petty branch of Cove creek. South-westward from Rainsburg, along the road leading across Evitts' mountain, the Utica shales are soon reached again. Martin's hill in this township is made up of the hard sandstones of the Hudson and lower Medina, and according to the statement of Col. May, who aided in running the township line, its top is basin shaped, widening southward.

On the road leading across Evitts' mountain to Centerville a synclinal was seen at the boundary between school districts 1 and 2, and nearly in a line with the northern termination of Martin's hill. Thence exposures of the shales are fairly good to where Cove creek is crossed above Schoolhouse No. 1. There the dip is south-westward at 18 degrees. No further good exposures were found until the creek had been crossed for the last time in ascending the mountain; but beyond that, the red beds of the lower Medina are frequently shown, either vertical or slightly inclined toward the east. The white Medina is reached at the township line, where it is dipping eastward at 70 to 80 degrees. Like Tussey, Evitts' mountain north from the Southampton line is monoclinal and its dips are eastward.

The lower Medina rocks form a subordinate ridge or terrace on both sides of the Cove, usually quite distinct, but occasionally rendered somewhat obscure on the east side, where Cove creek approaches closely to the mountain's foot. The southern part of the cove is gently undulating, having been planed down by Cove creek and its numerous tributaries; and this bottom-land extends northward for several miles along the east side. The great Lower Silurian limestone is the immediately underlying rock in the greater part

of the cove, but its area narrows in Snake Spring township and ends at the north with the cove, being covered again by the Utica and Hudson rocks. An irregular ridge, known as Middle ridge, follows the cove, lying for the most part somewhat west from the middle line.

The limestone is reached on Cove run near Mr. Perry Morgart's house at somewhat more than two miles southwest from Rainsburg; and a very fair exposure above Mr. G. W. Deal's house shows the limestone dipping S. 55° E. at 20 degrees. From this locality northward to the Juniata river exposures are rare on the west side of the cove. Fragmentary exhibitions of limestone were seen on a road leading past School-house No. 5 to the foot of Evitts' mountain, but they do not show the dip and suffice only for determining the limits of the series. An exposure near Charlesville shows the limestone dipping S. 55° W. at 8 degrees, but no exposures were found aside from this and the relations of the dip remain unexplained. Some limekilns were seen along this road, but they appear to be supplied from loose material gathered on the surface and not from quarries.

The road becomes sandy at a short distance north from Charlesville and the sand becomes deeper thence almost to the Juniata, there being but one interruption and that very short. The middle ridge is very sandy and extends here to the narrow valley following the foot of Evitts mountain. Occasionally a fragment of *brown hematite* occurs along the road and on this side of the ridge, but there is no evidence yet that that ore exists in economic quantities on this side.

The east side of the cove affords no exposures for nearly three miles north from Rainsburg. The road runs on the broad "bottom" of Cove creek, which reaches to the foot of the mountain and shows here and there only a fragmentary exposure of waterworn limestone. The surface is covered with bowlders of sandstone and limestone and the limit of the latter series could not be ascertained. Some *brown hematite* was seen just east from Cove creek on A. Weisel's property at about a mile south from D. F. Koon's mill, but no attempt has been made to ascertain the quantity. One

of the higher limestones is quarried and burned for agricultural purposes by D. F. Koons. A sample taken from his quarry was analyzed by Mr. A. S. McCreath, with the following result:

D. F. Koons' limestone, No. II.

Carbonate of lime,	90.589
Carbonate of magnesia,	1.929
Oxide of iron and alumina,	0.590
Sulphur,	0.018
Phosphorus,	0.005
Insoluble residue,	6.410
Total,	<u>99.541</u>

Turning westward here, one crosses a low sandy ridge on which much cinder-like *chert* occurs in irregular fragments, with here and there a bit of *brown hematite* ore. The quantity of the latter is evidently insignificant. Beyond the cross-roads an outlier of the middle ridge is crossed, which is sandy, covered with loose fragments and shows no outcrops. This road crosses the Middle ridge, but very little ore was seen near it. Returning and following a branch of Cove creek, one finds abundance of cindery *chert*. On L. Whetstone's property, fragments of Medina and Hudson sandstones occur in great quantity and the soil is very sandy. *Brown hematite* is said to abound on this property, but careful examination of many stone-piles and of long lines of stone fence was rewarded by the discovery of only a few fragments. There appears to be not a little ore on the J. P. Diehl farm, which adjoins the last. The road is very sandy thence to the farm belonging to A. Whetstone's heirs, where much *brown hematite* is piled up. There is much of this ore here near the road but no test has been made to ascertain the available quantity.

Exposures of limestone occur frequently between this and the Juniata river, and the dip varies from 27 to 35 degrees between S. 40° E. and S. 35° E. The rock is quarried and burned by several of the farmers for agricultural use; but only the higher beds are employed for this purpose.

Strophomena alternata and *Calymene senaria* were obtained at an exposure half a mile south from the river.

Many exposures of limestone were seen on the road following the south side of the river and the Middle ridge, carrying much *brown hematite* ore, was crossed about midway in the valley.

The Bedford division of the Pennsylvania railroad crosses the valley, following the south side of the Juniata river. Numerous side cuttings exhibit the structure.

The white Medina sandstone is well exposed at the township line directly under the crest of Tussey mountain at little more than one fifth of a mile east from Mount Dallas station; while immediately west begins the red or lower Medina, of which exposures continue to some distance beyond the station. The details of this will be given further on in another connection. The road crosses the river immediately above Mount Dallas station. No rock in place is shown on the south side of the river until the mouth of Cove creek is reached, immediately above Ashcom station; but exposures south from the river show that east from Cove creek along the railroad there is a concealed gap of nearly 600 feet which is filled with limestone dipping at very nearly 45 degrees. The section may then begin with

1. Limestone. 45 degrees eastward; horizontal distance 600 feet, 420'
This limestone is dark in the upper part but becomes lighter colored below. For the most part it contains little chert but some of the beds are magnesian. Fossils appear to be few, *Strophomena alternata*, *Leptaena sericea*, and *Calymene senaria* being the only forms observed.
2. Limestone, 40 deg. Horizontal exposure 2112 feet, . . 1351'
Dip east. The exposure begins immediately below the mouth of Cove creek; the upper beds are light gray to blue, and clean, but the rock rapidly becomes silicious and, at a distance of 875 feet, lumps of white chert were seen, which continue to 1400 feet. Thence the rock becomes more and more silicious so that at times it is nothing more than a fine grained calcareous grit. At 1750 feet, black chert was seen and in a bed just beyond that some obscure *cyathophylloid* corals were seen in a bed containing much nodular chert. For the last 200 feet of the exposure, thin streaks of chert are so numerous that the rock weathers with a fretted surface. Chert makes up fully one third of the mass in this portion.

3. Concealed horizontal distance of 616 feet, 419'
4. Limestone, 43 degrees. Horizontal exposure, 616 feet, . 419'

Only fragmentary exposures occur within this interval on the south or railroad side of the river, but the exposure is almost continuous on the opposite side. The dip is eastward at 43 to 45 degrees.

Here the river bends southward and a fine cliff of limestone with south-east dip is exposed in a deep side cutting. This bend brings one again to some of the higher beds shown in the last exposure, but the base of the section is reached at Lutzville station. Limestone is shown on the other side of the river opposite that station, where it dips eastward at from 25 to 35 degrees and appears to be somewhat contorted.

Everything is concealed beyond Lutzville for a distance of 1408 feet, and only partial exposures occur in the next 350 feet, to be succeeded by another blank of 350 feet. Thence for 570 feet, cherty calcareous grit is shown, weathering with fretted surface and dipping S. 45° E. at 33 degrees. No exposure was found in the next 175 feet, but beyond that there are more or less continuous exposures of sandy limestone or calcareous sandstone, not very cherty. The dip diminishes westward, being 20 degrees where first observed and becoming only 9 degrees where the exposure ends just above the mill station. The total horizontal exposure of this rock is 2450 feet.

From this point to the deep cut, a distance of 1050 feet, everything is concealed. Exposures begin again in the cut and continue along the direction of dip for 440 feet, showing the beds dipping almost south-east at 65 degrees. The axis of the Evitts' anticlinal was crossed somewhere in the last concealed interval. The track turns southward at the west end of this cut and holds that course to Jameson's station, where it again turns westward. All exposures cease at the station and nothing more is seen until the white or upper Medina is reached on the west side of Evitts' mountain.

Along the Chambersburg and Bedford pike, fine exposures are shown in the gap through Evitts' mountain. Beginning at the base of the white Medina sandstone, imme-

diately below the bridge, one finds a mass of red sandstones and shales, of which the exposure continues for somewhat more than 1600 feet, or to the sharp northward bend of the road. Sandstone predominates in this mass and occurs in beds from 1 to 20 feet thick ; it is very fine-grained, for the most part grit-like and exceedingly hard ; some beds show reddish yellow spots of ferruginous clay, which weather out and after exposure leave the subject pitted. This should be a durable building stone ; fragments thrown out during the construction of the pike in 1816 still retain sharp corners. But the color of the rock is somber and many beds would be somewhat difficult to dress. The shale is reddish to brownish red, is arenaceous and shows irregular bedding. *Rhynchonella capax* and *Ambonychia radiata* were obtained from one of the shaly beds.

The structure is very complex here and the rocks describe more than one fold in this exposure, so that the exact thickness of the series can be ascertained only approximately. Beginning at the top near the turnpike bridge, the beds are dipping at from 85 to 90 degrees eastward for a distance of about 400 feet or to the first house. There an anticlinal is distinctly indicated and the dip on the easterly side of the fold is eastward at 80 degrees for about 420 feet. Suddenly the dip becomes vertical as the synclinal is crossed, and this dip continues for 340 feet. Beyond this, for 186 feet, the dip is eastward at 45 degrees, apparently marking the eastern side of a second anticlinal ; a synclinal is well shown for a distance of 156 feet, the folding being fully exposed ; beyond, to the curve in the road the dip is eastward at 45 degrees, the western edge of another fold.

The mountain is divided longitudinally at the first fold and thence northward the secondary ridge or terrace formed by the lower Medina and upper Hudson is very distinct.

The limestones of the Trenton are shown in the river bank where the stream makes its bend and thence continue until the outcrop is crossed by the stream near the old Willow Grove hotel.

Following the turnpike one finds the sandstones and shales passing imperceptibly into argillaceous shale, more

or less sandy and mostly brownish. The bedding is not always distinct, but here and there before the Willow Grove hotel is reached beds are seen showing a dip of nearly 70 degrees. The Utica shales are exposed at the Willow Grove hotel, where they are black and fissile. The line of separation between them and the underlying limestone is clearly marked.

The limestone is quarried and burned at Willow Grove where it dips eastward at nearly 80 degrees. This abrupt dip is maintained until very near the church and school-house where the crest of the anticlinal is reached and the dip becomes more gentle, being hardly 40 degrees eastward. A sharp synclinal was crossed just west from the Reformed Church, near Mr. J. G. Hartley's property, which should be crossed by the railroad somewhere in the concealed interval above Lutzville station. Beyond the church, exposures are very bad for a considerable distance. The road becomes sandy at a little way east from the church and school-house, for there it begins to rise upon the Middle ridge. Thence to beyond Mr. J. G. Hartley's property the sand is heavy and only here and there does a crag of limestone appear. This ridge shows the same features as on the south side of the river where it carries *ore* on the Diehl and and Milburn properties; but north from the river to beyond the pike, it is very high and the coat of *débris* is very thick. Fragments of the Medina, and Hudson sandstones abound with larger fragments of cindery *chert* belonging low down in the limestone series. *Iron ore* occurs here. Several years ago, the Kemble Coal and Iron Company made some extensive openings on the Hartley property; much excellent *brown hematite* ore was discovered, but the workings were abandoned because too much of the ore is small, and lump ore was needed by the company. Samples of this ore were taken, which were analyzed by Mr. A. S. McCreath with the following result:

J. G. Hartley's iron ore, No. II.

Metallic iron,	57.400
Sulphur,	0.025
Phosphorus,	0.119
Insoluble residue,	4.040

Exposures are comparatively rare along the pike from this point. A gray limestone containing some chert and weathering very dark gray or grayish brown was seen at several places between Mr. Smouse's house and that belonging to Mr. W. Hartley. On the road leading from the former house to the river this limestone is well exposed and some of the higher beds are shown. The latter are bluish gray and some of them weather almost white. The rock is clean and almost free from chert, so that it is highly prized for lime.

All these beds belong to No. 1 of the limestone section along the railroad. The highest limestone of the series are exposed on the turnpike at and beyond W. Hartley's house, the last of them being shown in the field at say 40 rods east from the house. These beds are light bluish gray and weather almost white. The Utica shales are imperfectly shown in the field and the Hudson brown and yellowish shales are poorly shown in the fields and in a narrow ravine.

The total horizontal exposure of the Utica and Hudson is not far from 1040 feet and the dip varies from 35 to 60 degrees, so that the actual thickness of the mass is probably very nearly 700 feet.

The exposures of the red rocks begin at the hill top where the road begins to descend toward the railroad crossing. The succession of the beds beginning at the top of the series near the township line is as follows:

Medina sandstones, No. IV.

1. White sandstone, 344'

The bedding is very irregular and the rock is badly twisted at the base. The dip is eastward, varying from 50 to 75 degrees, but averaging between 50 and 55 degrees.

2. Red sandstones and shales, horizontal exposure somewhat more than 1200 feet. The rock is red, micaceous, cleavage planes of the sandstone showing films of quartz; speckled, hard, in thin laminae as shown on the weathered surface. The shales are red to brownish red. Toward the base the sandstones become reddish gray. The exposures are as follows:

1. Dip, 48 degrees eastward, 10'
2. Concealed, hor. dist., 90', 67'

3. Dip 66 degrees E., 200' hor.,	182'
4. Dip 65 degrees W., 15' hor.,	18'
5. Concealed, 170' hor.,	153'
6. Imperfectly shown. Dip 65 degrees E., hor. dist.,	130', 117'
7. Dip 65 degrees E., hor. dist., 175',	157'
8. Dip 80 degrees E., hor. dist., 90',	88'
9. Dip falls to 70 degrees, hor. dist., 150',	140'
10. Dip falls to 35 degrees, hor. dist., 160',	120'

The exact thickness of the red beds cannot be made out from these exposures as there is a defect at the base of No. 3, making impossible to find where the reversal of dip as shown in No. 4 begins. In like manner the place where the easterly dip is regained is concealed. The white Medina lies wholly in the adjoining township of West Providence.

Turning northward at the first road west from Mr. Hartley's house, one finds the higher limestones quarried and burned for agricultural purposes by several persons within two miles of the pike. The rock is good and yields an excellent lime. Samples were taken from Mr. D. Dunkle's property and sent to Mr. A. S. McCreath for analysis; he gives the following as the composition:

D. Dunkle's limestone, No. II.

Carbonate of lime,	85.892
Carbonate of magnesia,	10.637
Oxide of iron and alumina,	0.410
Sulphur,	0.075
Phosphorus,	0.005
Insoluble residue,	3.090
Total,	<u>100.109</u>

The massive gray limestone, cherty and weathering dark grayish-brown, is reached in the road very near H. Snyder's house, and within a short distance further north the Hudson rocks approach the middle of the valley.

On the western side of the valley, the road leaves the pike at School-house No. 2; thence the road follows closely the sandy ridge and for nearly 2 miles no exposures were found. But the deposit of sand and débris on that ridge becomes thinner northward, so that at three miles from the pike it is narrow and outcrops of limestone are shown on both

sides of the ridge. Limestone was seen in the road near the houses of J. Snyder and M. Weirham, in which the rock is dipping westward, but the exposures do not suffice for determination of the rate or exact direction. The terrace ridge of lower Medina bends eastward north from the pike and soon lies at but a few rods west from the road. As the surface rises, the outcrop of the higher rocks extends further eastward until, before School-house No. 4 has been reached, the Utica shale crosses the road. The limestone extends to a short distance further north in the middle of the valley as the deep trench of the creek keeps it exposed. Before the last fork of the road has been reached, less than two thirds of a mile from the northern limit of the Cove, the higher rocks stretch across and form the high dividing ridge separating this Cove from Morrison's Cove. The white Medina is shown at the crest of Evitts mountain barely half a mile from the road. The Hudson beds at the summit of the road are dipping almost W. N. W. at 30 degrees. *Strophomena alternata*, *Leptaena sericea*, and impressions of *crinoidal stems* were obtained from a block of the red clayey sandstone at the summit.

Crossing the summit here, one comes into

Morrison's Cove,

which embraces South Woodberry, Woodberry, and Bloomfield townships of Bedford county. The road from Friend's Cove leads into South Woodberry township and descending from the summit follows a branch of Beaver run.

No exposures were found along this road until G. Imler's house was reached, where the Hudson (?) sandstones were seen at the roadside and dipping westward. At almost due west from this house, the Medina outcrop changes its course on Evitts mountain from northward to west or a little south of west. Below Imler's, red shales and sandstones are exposed at the saw-mill, but not well enough to exhibit the dip satisfactorily.

As one approaches J. Stayer's house he emerges upon open country in which the surface is gently rolling and affords few exposures; the limestone series becomes the

immediately underlying rock very near this house, and thence westward the road runs on the limestone with the Utica and Hudson not far away at the south.

The great bend described by the Medina outcrop forming the southern boundary of Morrison's Cove continues for miles and thus the limestone area is much broader than in Friend's Cove. The structure of this widened area has been explained in a previous chapter.

Turning westward along the road leading to King township and following Beaver creek, one soon comes to a light blue limestone dipping S. 20° W. at almost 20 degrees, and dark blue limestone was seen at less than half a mile further. The direction of the dip is changed before reaching W. Kagarise's quarry, where it is S. 70° W. at 25 degrees. The limestone is quarried and burned here by Mr. Kagarise for agricultural purposes. A specimen was sent to Mr. McCreath for analyses, who reports the following as its composition :

W. Kagarise's limestone, No. II.

Carbonate of lime,	90.857
Carbonate of magnesia,	3.216
Oxide of iron and alumina,	0.360
Sulphur,	0.108
Phosphorus,	0.006
Insoluble residue,	5.130
Total,	<u>99.672</u>

In the meantime, the course of the Medina outcrop on the loop between Evitts and Dunning's mountains has changed ; at first south of west, it soon becomes westward and afterwards almost northward. At a point, S. 75° W. from W. Kagarise's house, the course becomes northward, north of west and then north-west to a point almost due west from from Burger's store, where it turns southward and passes into Bedford township.

The Utica shale lies at but a few rods away from the road until within a mile of School-house No. 7, but there its outcrop bends away from the road and does not reach it again until somewhat more than a mile beyond the School-house, where it crosses the road. Thence to the township line at

the north it lies east from the road leading to Roaring Springs. The limestone is burned at several places along the road. The dip near School-house No. 7, on J. Stayer's property, is S. 70° W. at 30 degrees.

Following the road past the Mountain hotel up the side of Dunning's mountain, one soon comes to the lower Medina sandstones dipping eastward at 80 degrees, but the exposures are imperfect and few. The white Medina is reached at the summit of the mountain, where one passes into King township, but the rock is not shown in place for some distance on either side of the road.

Returning now past the Mountain house and thence past School-house No. 7, one finds no exposures until just beyond the School-house. The limestone is shown in a small quarry on J. Stayer's property, where it dips eastward at 30 degrees, showing that an anticlinal passes between this and the other quarry on the same property, only a few rods further south. Here the rocks contain impressions of *Chaetetes*. The road now becomes sandy and soon crosses a sandy ridge which is better developed northward, only traces of it remaining here. Beyond the first fork in the road the sand becomes deeper, a condition which continues to the next fork in the road. Much cindery chert occurs here and not a little *brown hematite* was seen on the surface in small fragments. Near the next fork, at Mr. J. Brunbaugh's house, the sand practically disappears and the limestone outcrop is seen again. The dip in a quarry here is S. 30° W. at 15 degrees. A sample of the limestone was sent to Mr. A. S. McCreath for analysis and the following is reported to be its composition:

J. Brunbaugh's limestone from No. II.

Carbonate of lime,	93.014
Carbonate of magnesia,	3.329
Oxide of iron and alumina,	0.394
Sulphur,	0.046
Phosphorus,	0.002
Insoluble residue,	3.660
Total,	<u>100.445</u>

The easterly dip is regained before reaching the first fork

of the road east from New Enterprise, but the exposure at that place is too imperfect to give the rate satisfactorily.

No exposure was found south from New Enterprise for nearly two miles, but where the road turns toward Beaver creek a light blue limestone was seen. Where the road reaches Beaver creek and turns toward Pattonville, a fine grained, very light blue limestone was seen dipping eastward at 30 degrees; and within a very short distance an overlying dark blue limestone was seen in the road with a somewhat greater eastward dip. The Utica shales are shown at the first bend of the road above Pattonville. No further exposure was found until beyond the first gentle bend in the road east from Pattonville, where one comes to the sandstones and shales of the lower Medina, which are well exposed in the gap made through Tussey mountain by Yellow creek. The dip is 35 degrees eastward. The rocks are much cross-bedded, brownish, and have the characteristic pitted surface in many layers. The shales are reddish brown. These rocks make a well-defined ridge along the west side of Tussey mountain. As nearly as can be determined, the horizontal exposure is 2,100 feet, which shows a thickness of very nearly 1,200 feet. No anticlinal could be detected here. The white or upper Medina is reached on Yellow creek at the township line and the great mass of that rock lies in Hopewell township.

The road leading northward from Pattonville to Woodberry passes over limestone all the way and one of the higher beds is quarried extensively near Waterside, on a branch of Yellow creek. The base of the Utica is reached very near M. Dougherty's house in the bend of Yellow creek.

Leaving this road at the Lutheran Church below Waterside, and turning westward, one finds blue non-cherty limestone until R. Z. Replogle's house is reached; but thence exposures are rare and fragments of light colored cinder-like chert are shown on the surface without any fragments of other rocks. Dark chert replaces the other on top of the hill. An exposure near Jacob Furry's house shows the limestone dipping eastward. No ore was seen along this line.

An exposure near A. Haderman's house shows the limestone dipping N. 25° W. at 50 degrees, but the easterly dip is regained before D. Snowberger's house has been reached. A massive, gray, silicious limestone, weathering to very dark brown, was seen on S. Teeter's property, where its dip is eastward. This rock belongs high in the series, very near the blue limestone quarried near Waterside.

After passing D. S. Stayer's house, the road is sandy and the sand becomes deeper northward so as to make the road very heavy. This road follows a low ridge for nearly a mile, leaving it at the Metzgar property, where it descends into a narrow gully, which it follows for 50 rods and then again rises to the ridge. This ridge is barely 90 rods wide, shows no outcrops of rock in place, but is covered with débris in which were recognized fragments of Medina and Hudson sandstones and of the cherty limestones. No fragments of *brown hematite* were seen until after passing Mr. Metzgar's house, but thence into Bloomfield township such fragments are abundant. Ore was obtained on this ridge at the Lytle bank, where mining was done 40 years ago to supply Elizabeth furnace at Woodberry. Still further along this road in Bloomfield township are the Kaughman and Longenecker properties, on which loose ore is abundant and from which some ore has been taken. These properties were not examined.

Returning to the line between Bloomfield and South Woodberry townships and turning west, one soon crosses the western edge of the sand, but within a few rods comes to another sand ridge which evidently unites with the former at a little way north from the township line. It is of some interest in that it has proved to be very rich in *ore* at more than one locality.

Explorations have been made at various times during the last 50 years on the property of Mr. G. Bender, in Bloomfield township, immediately north from the township line. Ore was obtained here for the Elizabeth furnace 45 years ago and the pits made at that time are still recognizable though nearly filled up. The Cambria Iron Company thoroughly prospected 23 acres about 9 years ago. *Brown*

hematite occurs in all the pits and a handsome fibrous limonite is present in one. The last is said by Mr. Bender to occur in place but the ore is loose in the other pits. As all the pits have been so far filled up by dirt and water as to conceal everything, statements respecting the value of the ore must be given only in accordance with the information received. Much ore, however, lies on the dumps of nearly all the pits. The sand is good and if washed would do for the manufacture of glass. The clay is fine and appears to be good, but no test of it has been made to determine its quality.

Ore is present on the adjoining farms belonging to Reininger and Wyant, within South Woodberry township, but no attempt at development has been made. The conditions are similar to those observed on the Bender farm. Following the ridge southward one soon comes to the Jacob Ripley farm, on which the ridge attains its greatest development; southward it diminishes and practically disappears on the road leading westward from New Enterprise. Ore was taken from the Ripley farm nearly 40 years ago to supply Elizabeth furnace near Woodberry. The old pits are full of rubbish, but not a little ore still remains about them. This ore was sampled and the sample forwarded to Mr. A. S. McCreath for analysis. Its composition is as follows:

Jacob Ripley's ore from No. II.

Metallic iron,	52.750
Sulphur,	0.026
Phosphorus,	0.096
Insoluble residue,	9.910

A pit was opened recently on Jonathan Ebersole's farm, which adjoins that belonging to Mr. Ripley. A good showing of ore was found and in quality it is the same with that just described. As far as could be ascertained the ore is loose; but no direct examination could be made as the pit is partly filled with rubbish.

The western edge of this sand ridge lies at but a short distance east from the road running south from Lafayetteville and the top of the limestone series lies between it and the road. The road from Lafayetteville to the Mountain house

lies in shales of Hudson age which, for the most part, are yellowish and at the only good exposure seen dip westwardly at from 55 to 60 degrees. The lower Medina forms a secondary ridge or terrace, while the white Medina, almost vertical, forms the sharp crest of Dunning's mountain.

Northward from Lafayetteville the road quickly passes into

Bloomfield township

and reaches the limestone again within a short distance. Turning eastward at Jackson Stuckey's house, one comes at once to the peculiar distribution of fragments which marks the "barrens" or ore ridges, and finds fragments of *brown hematite* by no means rare. *Columnaria alveolata* was seen here in large masses. Nearer Jacob Stuckey's house the ore becomes more plentiful. It abounds on the surface of that farm. Much ore was obtained here many years ago for Elizabeth furnace. But with the ore occurs a jaspersy rock bearing much resemblance to a form which is present in many ore pockets in Virginia, where it contains about 45 per cent. of metallic iron. Samples of this material were taken from the Stuckey farm for analysis by Mr. A. S. McCreath. As appears from the following it is utterly without value and as it occurs abundantly it detracts greatly from the value of the property. The composition is

Jacob Stuckey's ore from No. II.

Metallic iron,	7.450
Sulphur,	0.026
Phosphorus,	0.044
Insoluble residue,	86.960

Exposures of limestone begin almost immediately beyond this farm and continue without material interruption to Mr. Bayer's farm, showing an eastward dip all the way. The rock is burned at several places and yields a good lime. Occasional exposures were seen between Bayer's and Coveburg, but for the most part they are insignificant, that near School-house, No. 12, being the only one to show the dip. There it is westward, so that a synclinal has been crossed since leaving Bayer's.

Turning off at Coveburg toward Woodberry, one rises at once on a long bench, affording no exposures of rock, but deeply covered with débris in which fragments of cindery chert occur abundantly. Further north this ridge is known as the "Barrens" and it is the same with that further southward which carries the ores on the Bender, Kaughman and Longenecker properties. A few fragments of brown hematite were seen at a little way from Coveburg, but the ore does not appear to be abundant until C. L. Hoffman's farm is reached. This richer part of the ridge extends to P. Keagy's house, but thence the fragments are fewer.

A petty exposure near Keagy's shows an eastward dip, but a sharp reversal of this dip was seen within a few rods of the pike, where the limestone dips westwardly at 60 degrees. The easterly dip is regained before the pike is reached. Surface *ore* occurs in small quantity on both sides of the Pattonsville and Hollidaysburg pike south from Woodberry.

Many outcrops of limestone were seen along the Hickory Bottom road and the rock invariably shows an eastward dip. No ore was seen in the neighborhood of this road. Leaving it at C. Carper's lane near School-house, No. 10, one soon comes to the higher limestones of the group, light blue to dull grey and weathering white. This rock dresses nicely and is an admirable building stone. It is quarried by Mr. Carper and burned into lime for agricultural purposes. A sample analyzed by Mr. McCreath showed the following composition :

C. Carper's limestone from No. II.

Carbonate of lime,	69.107
Carbonate of magnesia,	23.951
Oxide of iron and alumina,	0.542
Sulphur,	0.266
Phosphorus,	0.008
Insoluble residue,	5.790
Total,	<u>99.664</u>

The dip at this quarry is almost due east at 25 degrees. The Utica shales should be seen near John Smith's house, east from Mr. Carper's, but no exposures occur there. The
12 T^o.

lower Medina sandstones are reached beyond that house and form a distinct ridge. A few exposures of limestone were noticed along Hickory Bottom creek between this place and Waterside.

Returning to Woodberry, one finds a good exposure of the calcareous grits at the mill near the village, immediately above the site of old Elizabeth furnace. The rock contains more silica than carbonate of lime and dips eastward gently.

Brown hematite occurs on several properties near Woodberry. The Garretson farm about a mile west from Woodberry and on the eastern slope of the "barrens" was tested many years ago for Elizabeth furnace by Dr. Schoenberger. Much ore exists there but the value of the deposit cannot be regarded as fully determined. Surface ore occurs on the Fox and Oelig farms nearer Woodberry, while north-west from that borough test holes have been made on R. Hoover's property with satisfactory results, a promising nest having been struck in one of them at 30 feet from the surface. Supplies for Elizabeth furnace were drawn largely from a locality on the "barrens" known as the Baech orchard; but this property, which has lain idle for many years, was not examined.

Going eastward from Woodberry on the road leading to Raver's gap, one finds for nearly a mile occasional exposures of limestone dipping eastward at about 20 degrees; but the dip becomes 28 degrees near Mr. Bassler's house. There the rock is fine-grained and free from chert, though much chert is scattered about on the surface. Thence for nearly a mile there are no exposures, but as one enters the Terrace ridge below C. Miller's house, he finds the Hudson shales and sandstones dipping eastward at 27 degrees, while at a little way further east the lower Medina is dipping in the same direction at 33 degrees. The Hudson beds contain *Calymene senaria*, *Zygospira erratica*, *Chaetetes lycoperdon* and crinoid stems. The lower Medina sandstones are red or reddish-brown on the fresh surface and contain small nodules of ferruginous clay which weather out and give the surface a pitted appearance. Lumps of indurated clay are of frequent occurrence in this sandstone.

From this locality to the summit of the gap, one rides only in the red shales and sandstones of the Medina which hold here and there a thin bed of yellowish sandstone. Exposures cease long before the summit is reached and the road passes through a thicket of barn oak and scrubby pine which is practically impenetrable. Some short exposures near the head of Maple creek show that the dip is undulating but no details could be gathered. Before coming to Maple creek the road crosses a sharp point in the hill and at a little way south the looped outcrop of the upper or white Medina is clearly shown.

The road to Henrietta mines leaves this road at a little way above C. Miller's house and goes northward, passing through the ridge of Hudson and lower Medina rocks. No exposure occurs until beyond the ridge where the valley of Clover creek is reached at a little way south from School-house, No. 7. Here a low ridge forms the western boundary of the valley and marks a line of fault, whereby the Trenton limestone is brought up against the Hudson shale. The ridge is covered with a deep coat of débris in which is much cindery chert with fragments of sandstone and *brown hematite*. Test pits sunk near the School-house did not reach rock at the depth of 15 to 20 feet.

Limestone is reached at the School-house, where a road turns off to cross Tussey mountain, and shows occasional exposures of limestone belonging to No. II. This rock, whose dip is eastward and not more than 30 degrees, is quarried for lime. Another fault evidently occurs near the foot of Tussey mountain, as there is not space enough for the whole of the Utica and Hudson in the interval between the first exposure of the lower Medina and the last exposure of the limestone. The red Medina rocks are shown near the sharp bend in the road, where they are dipping eastward at 60 degrees. The Terrace ridge formed by these rocks along Tussey mountain extends northward into Blair county. The white Medina forms the crest of Tussey mountain.

Returning to the school-house and going northward to where the road turns westward near the county line, one finds the ore-bearing ridge decreasing in height so that it

becomes insignificant soon after passing into Blair county. The Cambria Iron Company at one time mined ore just south from the county line, but the works were idle when the locality was visited. They have been well described by Mr. Franklin Platt in report T of this survey. The yellow Hudson shale was seen near the crest of the ridge but thence for nearly half a mile no exposures were found. Beyond this concealed gap a blue slaty limestone was seen in the road, dipping eastward at 32 degrees. This continues to the cross-road in occasional exposures and becomes cherty in the lower layers. The upper part is clean and is quarried for lime by D. S. Breidenthal and others on the west side of the ore ridge.

Turning southward at the church near the county line, one finds no exposures on or near the road. A lane leads from M. Bechtel's house to that of Mr. Replogle and another thence to the School-house, No. 5, on the Markleysburg and Pattonville pike. No exposures occur between Bechtel's and Replogle's except one near the western end of the lane which shows an easterly dip. Fragments of chert are numerous, dark rock prevailing to Detwiler's and light colored rock thence to Replogle's. Large masses of the latter were seen projecting from the surface and they may be in place, but the exposure was insufficient to determine the matter.

An anticlinal is indicated at Replogle's but the easterly dip is regained within a short distance and appears to prevail until the pike is reached. Much chert is scattered over the surface. No exposures were found on or near the pike until within a few rods of the county line, where a fine-grained, clean, light blue limestone was seen dipping gently eastward. A gentle anticlinal was crossed between this and the Bloomfield ore banks but its extent was not ascertained as the sand of the "Barrens" effectually conceals everything.

On the west side of the "Barrens" one again comes to a sand ridge, much deeper and more extensive than any yet referred to. Its width appears to be somewhat more than 120 rods. The Bloomfield ore mines are in this deposit. These excavations, the result of many years' work, show the deposit at the pits to be fully 60 feet deep and to consist

of sand and fireclay holding fragments of sandstone, chert and brown hematite, which are distributed irregularly. The ore occurs in great nests and generally is free from coarse chert; but sometimes the admixture is such as to render the whole worthless. Ordinarily the rocks aside from the ore have been reduced to sand, which is easily removed by agitating with water.

These mines, which extend northward into Blair county, have been described in detail by Mr. Franklin Platt in report T and repetition is unnecessary here.

Following the road leading westward from the ore mines, one finds the sand continuing until within 1200 feet of the old brick School-house, No. 3, on the road leading from Roaring Springs to Lafayetteville. At that distance from the school-house, sandy limestone is exposed which dips eastwardly. A better exposure occurs in Eli Holsinger's field at a little way south, where the dip is almost due east at 28 degrees. The lower part of the limestone at this exposure is grayish blue, hard, and fossiliferous; but the fossils are minute, being for the most part fragments of small trilobites. The upper part is blue to almost black and slaty. A bed higher up the hill is quarried and burned into lime for agricultural purposes; while further east on this farm the Bloomfield ridge is reached and fragments of *brown hematite* are scattered plentifully over the surface.

Southward the road becomes very sandy at about one fourth of a mile north from Baker's summit and just beyond the cross-roads at that place are the ore pits formerly worked by the Cambria Iron Company, which have been fully described by Mr. Platt in report T. The conditions are the same with those observed at the Bloomfield mines. The material was screened to remove the dirt, only the coarser ore being retained. The work has been idle for several years.

Thence the road is very sandy and ore occurs so abundantly in many fields on both sides, that some localities it has been hauled off for use in repairing the road. Pits sunk on D. S. Long's farm found much *ore*. Here a road turns westward to cross Dunning's mountain and within

300 feet passes beyond the western edge of the sand. The limestone is exposed with an easterly dip of 30 degrees. It is somewhat sandy, but is quarried and burned into lime for farming purposes. The western edge of the limestone is reached at about 10 rods below J. Long's house, but no further exposure occurs until at the house one finds the Hudson shales with characteristic fossils. The Lower Medina sandstones are shown at a little distance further up the road where they are dipping eastward at 23 degrees. Thence to the summit of the mountain rocks of Medina age prevail, the white Medina forming the crest; but exposures are poor.

Returning to the Lafayetteville road and continuing southward, one finds the *ore* abundant on J. Long's property; openings were made in his field near the School-house which showed much lump ore. Loose ore in sand occurs on Mr. Hinkle's property and much has been collected on J. L. Holsinger's farm, which has been used in repairing the road. This ore is excellent material for macadamizing roads. The Bloomfield sand area appears to end on the Holsinger farm; at least it has been so narrowed by erosion that to trace it further is difficult and its continuity is certainly lost. Traces of it remain further south on the Barley place where ore was found in the detrital deposit, while an excavation was making for a new house. Here one is in the deep valley of a branch of Yellow creek and the older deposit is lost in the newer one.

No exposures were found on the road to Barley's tannery until near J. Heltsel's house, where a light blue limestone, weathering almost white, was seen, which is succeeded by a dark blue almost black limestone, ringing when struck. No exposures occur beyond this until the Utica shale is reached just below the tannery. Some fragments of *brown hematite* were observed near Heltsel's house.

No ore was found south from this on the Lafayetteville road but some occurs at a little way east from it on S. Brumbaugh's farm. At 50 rods north from School-house, No. 1, the rocks in the road dip almost west at 25 degrees and the axis of an anticlinal is shown at the School-house

on the farm of S. & M. Snyder. Within a short distance beyond this, one comes to the fork of the road at Jackson Stuckey's house.

CHAPTER IX.

Black valley, or the region between Tussey mountain and Warrior ridge.

Black valley lies between Tussey mountain at the west and Warrior ridge at the east, the width from crest to crest in a direct line being about one mile, and showing comparatively little variation except near the loop described by Tussey mountain in Hopewell township. Within Bedford county, it embraces parts of Southampton, Monroe, West Providence, Hopewell and Liberty townships. The white Medina forms the crest of Tussey mountain, the Clinton and the shaly beds of the Lower Helderberg occupy the valley, while Lower Helderberg forms the mass of Warrior's ridge, Oriskany forming its eastern slope.

Entering the county from Maryland, one finds few good exposures until he comes to Isaac Wilson's farm. The Red ridge of the Clinton, containing red shales and some limestone belonging to the top of that group, is here known as Buckskin ridge and attains to considerable height, while the main ore ridge of the Clinton occasionally becomes equally bold. The massive limestones of the Lower Helderberg are rarely exposed and the shaly limestones at the bottom of that group are shown but indifferently.

The *fossil ore* of the Clinton has been prospected on Isaac Wilson's farm near Mrs. Willison's house, which stands on the ore ridge. The exposure shows

Ore,	.....	8'
Clay,	.....	0' 4"
Ore,	.....	1' 3"

The upper bed has a little *brown hematite* and is considerably harder than the lower. The ore from the upper bed

was sampled and the sample was sent for analysis to Mr. A. S. McCreath, who gives the following as its composition :

Fossil Ore from Isaac Wilson's farm.

Metallic iron,	48.150
Sulphur,	0.022
Phosphorus,	0.298
Insoluble residue,	13.810

At a little way further north, a pit on W. Cheney's farm shows the ore nearly 4 feet thick, but the exposure is not complete. Mr. Cheney's house is on Buckskin ridge. An impure limestone is shown here at the bottom of the Lower Helderberg, which has been burned into lime. The road follows Buckskin ridge to David Fetter's farm, where a prospecting hole shows 3 feet of apparently good soft *fossil* ore. This exposure is not wholly satisfactory and a better exhibition was found within a short distance further north on Mr. Barkilow's farm where a pit shows

Ore,	1' 6"
Clay,	0' 2"
Ore,	0' 10"

and the bottom not seen. The ore is soft and free from pebbles. It was sampled and the result of analysis by Mr. A. S. McCreath is as follows :

Fossil Ore from Mr. Barkilow's farm.

Metallic iron,	54.150
Sulphur,	0.022
Phosphorus,	0.232
Insoluble residue,	7.790

which shows it to be an excellent ore.

The same bed has been opened on Hugh Wilson's property near the road leading across Tussey mountain into Bean's cove. The opening is a shallow pit, from the bottom of which a drift has been run for about 18 feet. The bed shows

Ore,	1' 1"
Clay,	0' 1"
Ore,	2' 3"

and dips south-east at 23 degrees. The ore contains some geodes of *brown hematite* and is clean. A fossiliferous

limestone was seen here at 60 or 70 feet below the ore in thin beds embedded amid greenish shale, which contains impressions of *fucoïds*. The bottom of the Clinton is reached on this road at a little way above A. J. Wilson's house and thence to the crest of Tussey mountain the road lies in the white Medina, which dips eastward or south of east at 25 degrees.

Following the valley northward, the road soon enters the Lower Helderberg. The massive limestones of that group are shown on the west side of Warrior ridge, but the exposures do not suffice for a section. On the road leading across Tussey mountain to Rainsburg by way of Neil's gap, exposures are few until near the township line, where the gorge becomes narrow and is inclosed by walls of white Medina sandstone, of which the beds dip eastward at 27 degrees. The dense forest effectually prevents measurements of the rock. The lower Medina sandstones are reached near the township line, but are poorly shown.

Returning again to the valley: an opening in the Clinton ore was seen near the old Rainsburg road, but it had fallen in and access to the bed was out of the question. Another opening was observed near the township line on a tract belonging to Mr. J. B. Williams, where 42 inches of ore are shown. No *brown hematite* was seen in the pit, but fragments are scattered abundantly over the surface. The ore, as exposed in the pit, contains amygdules of quartz and as far as seen is not very good. The dip is eastward at 35 degrees.

Here one enters into

Monroe township.

The Red ridge becomes smaller and the ore ridge is insignificant while Warrior ridge quickly loses its rugged mountain character. No openings in the Clinton ore were found south from Mr. Schwartzwelder's farm, and the pits on that farm had fallen in, so that no definite information respecting the bed could be obtained. For the most part, the ore is a red hematite, but there is some *brown hematite* and some of the ore has specks or flakes of specular ore.

Like that seen at the township line, this contains amygdulæ of quartz and so far as the surface material is concerned is decidedly inferior. Here the Red ridge lies at but a little way from the stream, known as Black Valley branch, and is not far from 30 rods wide.

A road leaves the valley at the old Stone Church, north from Schwartzwelder's, and crosses Warrior ridge. The top of the Lower Helderberg is reached at the summit of the ridge, Oriskany being only on the eastern slope. The highest bed of the Helderberg is cherty and yields readily to the weather, so that the surface is covered with "spalls." Lower down on the west slope is the massive dark gray limestone, very fossiliferous and with irregular fracture. It is burned into lime. A distinct bench occurs below this, on which many lumps of *brown hematite* were seen. The place of the ore was not ascertained, but it is said to have been uncovered in post holes on the second farm northward.

The Valley road lies in the Lower Helderberg, while the now insignificant Red ridge is distinct beyond the stream. The divide between this stream and a fork of Clear creek is reached on the farm of John Pennel, Sr., where the ore has been prospected extensively. This is about one mile north from Schwartzwelder's. The bed shows much variation. Seven openings were seen, in all of which the ore has been uncovered. At the first or most northerly pit, the ore is *brown hematite* as is also the condition at the second, where the thickness is 4 feet 6 inches; but of this, the bottom 18 inches is a conglomerate, made up of angular fragments of sandstone which are cemented by *brown hematite*. This is persistent for more than 100 yards. The three feet above show an excellent ore, of which a sample was made and forwarded for analysis to Mr. A. S. McCreath. The composition is as follows:

Fossil Ore from farm of John Pennel, Sr.

Metallic iron,	53.850
Sulphur,	0.025
Phosphorus,	0.723
Water,	12.534
Insoluble residue,	3.770

The ore in the other pits is the ordinary *fossil* but contains a little *brown hematite*. Some of it shows flecks of specular ore.

Returning to the road, one rides in Lower Helderberg and occasionally finds some lumps of *brown hematite* which have rolled down from Warrior ridge; but the valley encroaches on the ridge so that, opposite Mr. B. B. Steckman's about two miles north from Pennel's, the Oriskany is but a few yards away from the road. The *fossil ore* has been prospected on Mr. Steckman's property also, two openings having been made. The southern pit had fallen entirely shut before the time of visit and no examination of the ore in place could be made; but the bed is said to be three feet thick. The ore is mostly *brown hematite* with a little *fossil* ore and appears to be good. At about 300 yards further north the bed has been opened by a trench nearly 60 feet long, and not far from 150 tons of the ore lie on the dump. The ore is fully exposed at the end of the trench where it measures 6 feet 6 inches; but it is not compact and the thickness will certainly be less at a greater depth. The ore shows very little *brown hematite*, and few specks of specular ore. The material on the dump was sampled and the sample sent to Mr. A. S. McCreath, who gives the following as its composition:

Fossil Ore from B. B. Steckman's farm.

Metallic iron,	45.225
Sulphur,	0.022
Phosphorus,	0.175
Insoluble residue,	22.610

The Lower Helderberg limestone is quarried and burned by Mr. B. F. Mann at a little way north from Mr. Steckman's house. The rock is richly fossiliferous; *Streptelasma*; *Stromatopora concentrica*; *Favosites helderbergiae*; *Fenestella* and other bryozoans; *Strophomena rhomboidalis*; *Atrypa reticularis*; *Meristella arcuata*, *Streptorhynchus*; and *Cyrtoceras* have been observed during a casual examination. Here the road bends and enters the Oriskany, which it follows to the gap made through Warrior ridge by the

fork of Clear creek. There it leaves the ridge and within a few rods reënters the limestone.

An opening in the *fossil* ore was seen on H. Barton's property, about a mile from the northern edge of Monroe township. Only *fossil* ore is present, there being rarely a streak with a little *brown hematite*. The ore for the most part is soft and clean but some sandy layers were seen, which, however, make up but a small part of the bed. The thickness is between 5 and 6 feet. The last opening visited in this township is on the D. Means farm, very near the township line. There the ore was reached by a shaft at the depth of 60 feet and the bed is said to vary from 18 to 24 inches. No examination could be made as the shaft contains much water. Fragments lying about the mouth of the pit indicate ore of excellent quality.

Within a few rods one passes into

West Providence township.

In this township the road follows, for the greater part of the distance to the Juniata river, the shaly beds at the bottom of the Lower Helderberg.

The first opening seen in the *fossil* ore lies at some distance west from the road and is on the Scott and Russell tract near J. Buzzard's house. There a shaft, 38 feet deep, has been sunk at about 40 rods west from the Red ridge crest. When visited there were no means of descending the shaft and no measurements could be made. But the exposure has been measured by Mr. J. B. Williams, of Everett, who gives the section as

Brown hematite,	.....	3'
Clay shale,	.....	0' 6"
Fossil ore,	.....	3'

The *brown hematite* makes a very marked outcrop in the field south from the shaft but does not exhibit the dip. A large amount of ore lies around the mouth of the shaft. The *brown hematite* is, as far as can be judged from the material seen, of very uncertain quality and it would need to be sorted carefully. It contains much conglomerate like that seen on the Pennel farm. The *fossil* ore seen is slaty, fine-

grained, rather hard, and the fresh surface has a steely glitter. Whether this be a fair representation of the ore occurring in this shaft could not be ascertained, but the material was sampled and the sample sent to Mr. A. S. McCreath for analysis, who gives the following as its composition:

Scott and Russell fossil ore from southern pit.

Metallic iron,	17 125
Sulphur,	0.017
Phosphorus,	0.161
Insoluble residue,	69.180

No other openings were seen for nearly a mile. A by-road leading from the valley road to the Red ridge, turns off at a few rods north from J. E. Buzzard's house. Following this and crossing the Red ridge, one soon comes to an old opening at the corner of a field, which now affords no measurement, though the ore is shown in place. Such of the ore as lies on the ground around the pit is good. Several openings were seen in this field further south, but they were made many years ago and they show nothing now. A new opening was seen immediately beyond this field in which the measurement is

Ore,	1' 6"
Clay shale,	3' 2"
Ore,	1' 2"

And the dip is eastward at 35 degrees. The exposure of the upper bed is incomplete and the ore is badly water soaked. It contains some *brown hematite* but for the most part is *fossil*. Sandstone and shale overlie it. The ore from the lower bed is certainly good as far as can be determined by mere physical examination. It is more open in structure than the *fossil* usually is in this region.

Returning to the by-road and taking its other fork, one soon comes to a clearing, where at say 35 rods from the crest of the Red ridge, three pits have been sunk on this Scott and Russell tract. The bed was measured in one of the two southerly pits, where as nearly as could be made out the structure is

Brown hematite,	10" to 12"
Clay,	1" to 2"
Fossil ore,	8" to 10"
Clay,	3" to 4"
Fossil ore,	8"
Clay,	1" to 2"
Fossil ore,	15"

The dip is S. 80° E. at 44 degrees. The *hematite* is poorly shown at this pit but the *fossil* ore is well exposed as such. The *hematite* is better exhibited in the adjoining pit but that contains much water and there was no way of descending to make direct examination. A large quantity of the ore, *hematite* and *fossil*, lies at the surface near each pit. The quality of the *brown hematite* is uneven, some of that ore being mixed badly with yellow shale.

The third pit is at about 140 feet north from those just referred to. In it the measurement is

Brown hematite,	6" to 8"
Clay,	3'
Fossil ore,	17" to 20"

The *brown hematite* is not well shown but the fossil ore is exposed for several feet wholly undisturbed and dipping eastward at 46 degrees; the bed is divided nearly midway by a parting of yellow clay which is from one fourth of an inch to two inches thick. Three feet of yellow shale are shown below the ore, but no digging had been done to ascertain the presence or absence of the lower bed. The ore was sampled in the pit and the samples sent to Mr. A. S. McCreath who gives the composition of the ore as follows:

Scott and Russell; fossil ore from Northern pit.

Metallic iron,	54.950
Sulphur,	0.019
Phosphorus,	0.318
Insoluble residue,	9.600

At a little way north from Mr. Buzzard's house, the Kemble Coal and Iron Company began a tunnel with the intention of mining the ores just described. But the tunnel was stopped apparently before reaching the Red ridge. It has fallen in for much of its length, so that no direct examination can be made, but no fragments of the red sandstone forming the ridge were found in the tunnel dump.

The Lower Helderberg limestone is quarried by Mr. Stapleton at about half a mile south from the Juniata river. The lime is not white but is good. A sample analyzed by Mr. A. S. McCreath yielded as follows:

Stapleton's limestone from No. VI.

Carbonate of lime,	91.071
Carbonate of magnesia,	2.543
Oxide of iron and alumina,	0.440
Sulphur,	0.068
Phosphorus,	0.006
Insoluble residue,	5.590
Total,	<u>99.718</u>

Crossing the Juniata river one comes to the Bedford and Chambersburg pike. A limestone quarry is worked on the pike directly opposite the bridge. Beginning here and going westward to Dunning's narrows, the gap by which the river flows through Evitts' mountain, the following section was obtained:

Lower Helderberg.

1. Limestone, argillaceous, somewhat shaly, weathers dirty yellow; contains layers of chert at base, 20'
2. Limestone, blue, hard, very cherty, in layers from 2 to 10 inches thick, 9'
3. Limestone, compact, clean, greyish or bluish grey; is quarried and yields excellent though not pure white lime, 18'
4. Limestone, slaty, arenaceous to argillaceous, bluish gray, contains *Stromatopora*, 6'
5. Limestone, bluish, full of *Stromatopora*, which give it a nodular appearance and vary in diameter from 1 inch to 1 foot, 8'
6. Limestone, compact, blue, streaked with calcspar, 3'
7. Limestone, more or less shaly, some fossils, 6'
8. Limestone, very siliceous, 7'
9. Limestone, bluish-gray, nodular with *Stromatopora*; contains some other forms, 60'
10. Concealed, 700' at 50 degrees, 525'
11. Limestone, blue slaty, exposed near Mr. Barndoler's house on the pike, dip 46 degrees eastward, 7'
12. Concealed on pike and railroad, 150' hor. at 46 degrees, 106'
13. Shale on railroad, dip 46 degrees, 10'
14. Limestone, flesh colored, magnesian, exposed in railroad cut with dip eastward of 46 degrees, 12'

15. Limestone and drab shale, with same dip,	11
16. Concealed to Eichelbargers' mines, 260' hor., . . .	182'
17. Shale, drab, somewhat calcareous, exposed at the side- ling cut for Eichelbarger's mines, dip 45 degrees, . .	17'
18. Concealed, 350' hor.,	225'
19. Shales, yellow to drab, with dendritic markings, more or less fissile,	18'
20. Limestone, impure, dip 40 degrees eastward, . . .	11' 3''
21. Calcareous shale,	19'
22. Dark fissile shale,	12'
Total Lower Helderberg,	<u>1292' 3''</u>

Clinton.

23. Sandstone, reddish-brown, grit like, slightly calcar- eous, streaked with films of quartz,	11'
24. Red shale,	5'
25. Sandstone, like No. 23, but becomes shaly toward the bottom where its layers are much twisted,	15'
26. Imperfectly exposed, contains much red shale, which become variegated toward the base. A fair expos- ure at the engine-house shows the shales badly twisted and containing some streaks of impure lime- stone. A thin bed of fossil ore is said to have been found at the engine-house. The dip is not less than 60 degrees and the horizontal distance is 350 feet, . .	300'

Medina.

27. Sandstone, mostly very white, upper part not fully exposed; bedding very irregular and the mass is much twisted at the bottom. Dip increases down- ward, being 50, 55, 60 and 75 degrees eastward; the average dip between 50 and 55 degrees. This forms the bold bluff at the township line; the exact hori- zontal distance can be ascertained only by instru- mental measurement as the railroad passes around the bluff. It is not far from 425 feet,	344'
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The lower Medina is wholly within Friend's Cove or Snake Spring township. The thicknesses of the groups as obtained here are

Lower Helderberg,	1292' 3''
Clinton,	331'
Upper or White Medina,	344'

The highest bed of the Lower Helderberg is not shown on the pike and to obtain the full thickness of the group, 30 to 40 feet should be added to that given here. The thickness of the Clinton is less than at any other locality within

the district. As given it is probably greater than it should be, as the dip is bent to the north-east at the Red ridge, which is represented by Nos. 23, 24 and 25. The upper beds of the Medina for nearly 100 feet are very imperfectly exposed, so that no opportunity exists to ascertain whether or not the *block* ore bed is present.

The feature of especial interest in this section is the ore mine worked by Lowry, Eichelbarger & Co. alongside of the railroad, at the sharp bend of the railroad at say one third of a mile southwest from Everett station. The workings cover many acres and mining has been prosecuted with more or less vigor for nearly fifty years. The ore is *brown hematite* and occurs throughout a mass of sandy clay, evidently derived from disintegration of the shaly limestones of the Lower Helderberg.

The excavations reach northward for more than 100 rods, being very broad near the railroad but narrowing rapidly at a distance of nearly 60 rods, beyond which they become merely a deep broad cut in the clays, which rise to a height of 40 to 60 feet above the roadway. A small shaft, 20 feet deep, is worked in this cut and numerous short tunnels have been driven into the hillsides. A shaft, 135 feet deep, has been sunk at about 50 rods from the railroad and limestone is found at the bottom.

The western limit of the ore-bearing clays in the northern part of the excavation is a black shale, 3 or 4 feet thick, but nearer the railroad the clay over-rides this and passes westward, its limit not having been discovered yet. The drab shale, No. 17 of the section, extends northward for nearly 60 rods from the railroad and divides the clay, but at that distance it disappears, and thence northward no break has been found in the deposit. The limit on the east side has not been ascertained, but the clays certainly reach to the foot of the Mulberry ridge, as the ridge of Lower Helderberg is termed. The thickest part of the deposit is in the line of excavation, where the vertical distance from the top of the hill to the bottom of the shaft is 190 feet. How far the ore-bearing clay extends northward is not known.

The ore occurs irregularly. In a tunnel, 40 feet long, 20

streaks of ore were seen varying in thickness from one half of an inch to 3 inches. These streaks are lenticular deposits, thinning out in all directions and, as shown in the tunnels, having only small extent vertically; but the number is very great. The clay is tough but yields readily to the pick so that blasting is seldom necessary. No transported fragments were seen. Much of the ore is lump, but the greater part is small and must be washed to remove the clay.

The ore from this mine is shipped to Hopewell furnace, where it is used with *fossil* ore. Samples were taken which have been analyzed by Mr. A. S. McCreath. The composition is

Ore from Lowry, Eichelbarger & Co.'s mine.

Metallic iron,	42.650
Sulphur,	0.099
Phosphorus,	0.182
Insoluble residue,	18.730

The road leading northward from Everett into Black valley follows the western foot of Warrior ridge to the township line. Exposures are rare along this road until near the Tatesville mines, where the road lies in the Oriskany, which is well shown on the railroad as it passes through the ridge to Tatesville. The lower part of the sandstone is friable, readily disintegrating on exposure, while the upper part is coarse grained, somewhat conglomerate and resists the action of the atmosphere much better. This forms the crest of Warrior ridge.

The Kemble Coal and Iron Company have opened the *fossil* ore near Everett and have obtained much excellent ore from that mine. Near by is the mine of Lowry, Eichelbarger & Co. on the same ore. From these mines northward, the Red ridge is not always distinct from the Mulberry or Lower Helderberg ridge.

The Kemble Coal and Iron Company opened mines 19 years ago in this valley near Tatesville and work has been prosecuted in them more or less energetically ever since. The tunnel of the principal mine passes for 350 feet through the Red ridge, which is composed largely of limestone; behind

it is shale for 275 feet, under which is the ore. Two ore beds occur here, separated by from one eighth of an inch to six feet of clay or sandstone and shale. The upper bed is known as the "*fossil*," the lower as the "*twin*." The former is the main source of supply and yields ordinarily from 2 to 3 feet of soft ore. It has been followed in the mines of the company for nearly three miles and a half and the strike throughout, as reported by the superintendent, varies little from N. 13° E., while the dip is approximately 52 degrees eastward. The thickness of the ore shows material variations; occasionally for short distances, according to Mr. Trevorton's statement, the bed wholly disappears but the lost ground is more than made up by greatly increased thickness on both sides of the "want." For long distances, where the two beds are separated by a mere parting, the combined thickness exceeded 12 feet, of which about one half was excellent soft ore.

Mr. Trevorton, superintendent of the Tatesville mines, says that *brown hematite* and *fossil* ore occur together in the bed, but that the former practically disappears at somewhat more than 50 feet below the outcrop. A fine non-fossiliferous red hematite is present in occasional nests to the depth of 220 feet, but lower down only *fossil* ore is found. Calcareous ore, running low in iron, was cut at 325 feet from the outcrop and its presence led to the fear that the ore had changed finally; but this condition is merely local, as is well shown by the character of ore obtained in both the north and the south drift at equal distance below the outcrop. Samples of the ore were taken by Mr. Trevorton to show the shipping ore. These were sent to Mr. A. S. McCreath, who reports the composition as follows:

Fossil Ore from Tatesville Mines.

Metallic iron,	38.600
Sulphur,	0.018
Phosphorus,	0.213
Insoluble residue,	30.990

The great mass of the Clinton is made up of variegated shale, yellow and drab, with a little black. An irregular limestone is said to exist near the base of the group. The

block ore bed, about 1,000 feet west from the *fossil* bed, varies in thickness from 2 to 7 inches and yields a very fair ore, but it is too thin to be mined.

The Lower Helderberg is not exposed here between the railroad and the mouth of the tunnel. The horizontal distance from the Red ridge to the bottom of the Oriskany is a little short of 1,700 feet with an average dip of not far from 40 degrees. But a narrow anticlinal involving these rocks was seen in the tunnel. This is the southern point of the Coot-Tussey axis, whose sudden increase northward causes the loop of Tussey mountain in Liberty and Hopewell townships.

At a few rods from the Tatesville mines, one passes into

Hopewell township.

The Kemble Coal and Iron Company at one time mined the Clinton by a tunnel, 500 feet long, which opened just north from the township line; but this has been abandoned and all the ore is now taken out by the Tatesville tunnel.

Tussey mountain and Warrior ridge begin to diverge as they go north from this line. The Red ridge is followed without difficulty for somewhat more than a mile, but thence for a considerable distance exposures are very poor. The road lies in Lower Helderberg rocks to Piper's run. At that run, the middle or flaggy part of the Lower Helderberg is quarried and burned for farm use by Mr. J. Piper. The rock is dipping N. 50° W. at 10 degrees. It is blue, breaks with conchoidal fracture and rings sharply when struck. Fossils are few, but *Leperditia alta* and *Holopaea* were seen. The lime is only of moderate quality and much of it is ferruginous. Samples were sent to Mr. A. S. McCreath, who gives the following as the composition of the rock:

J. Piper's limestone from No. VI.

Carbonate of lime,	84.500
Carbonate of magnesia,	10.019
Oxide of iron and alumina,	0.713
Sulphur,	0.062
Phosphorus,	0.012
Insoluble residue,	4.820
Total,	<u>100.126</u>

Following Piper's run eastward, one finds the Lower Helderberg beds rising irregularly eastward until he reaches the Clinton at J. E. Ritchey's house. The red rocks are conspicuous here, as are also the yellow shales just beyond the house. But the axis of the anticlinal is passed quickly, for the Lower Helderberg is reached before the road crosses Piper's run and the massive limestone of the group is quarried for lime by Mr. Whitehill. Oriskany sandstone is shown at the bend of the road beyond the quarry.

Returning and taking the road leading from Mr. Piper's to the Yellow Creek or Pattonville gap, one follows the west side of Black Oak ridge, whose course marks the gradually increasing anticlinal. Tussey's mountain is bent westward as Warrior's ridge is bent eastward. No exposures occur on this road until near C. Spicer's house, where the shaly beds of the Lower Helderberg are imperfectly shown. At a little way further the road crosses a narrow anticlinal with a dip on the west side of 40 degrees. The Red ridge is distinct at A. Davis' house, where it lies at but a little way west from the road. It passes directly behind the next house. There one enters the Clinton, which continues thence to the mouth of Yellow Creek gap through Tussey mountain.

No further exposures were found until, in crossing the hill from Mr. Clapp's house to the road leading from Hopewell to Pattonville, an anticlinal was seen with the limestones dipping sharply toward the west, while the red beds are shown at the road. Turning here toward the gap, one finds the Clinton yellow shales describing numerous folds until, immediately behind Mr. Hall's house, the red rocks describe a double fold and soon run out. The white Medina sandstone is well shown at the mouth of the gap, where it dips eastward at 32 degrees. Further in the gap, the dip increases and at the township line the rate is 35 degrees; there the vertical measurement of the sandstone is very nearly 1050 feet, which indicates a thickness of 860 feet.

The road leading into the "corner" between Tussey and Coot mountain affords but indifferent exposures, while beyond the end of the road everything is concealed by forest,

so that the limit of the Clinton group as given on the map is practically conjectural. Coot mountain, the southern loop of Tussey mountain, is covered by an exceedingly dense forest which renders investigation impracticable.

Returning now to the fork of the road and continuing eastward or rather south-eastward across the foot of Coot mountain, one finds the Clinton rocks dipping eastward at 70 degrees ; but the dip decreases rapidly so that it is only 45 degrees in the road at S. J. Fink's house. Before reaching the road leading to the Methodist church, the dip is reversed to westward at 30 degrees, but it is eastward at 60 degrees at that road, while within 10 yards it is westward once more. These measurements were all made on the upper red rock of the Clinton, which is grit-like, very hard, dark red, and streaked with white. Its layers are separated by films of shale in which are great numbers of fucoids.

On the road leading by the Methodist church, evidences of ore were seen and a prospecting pit was found in yellow shale at a little way south from the church, but no ore was seen in the dirt round the pit. No good exposures were found beyond this point until the other side of Yellow creek was reached, where the Clinton shales are fairly well exposed and dip 10 to 15 degrees south of west. The same shales are dipping southeastwardly at 30 degrees at the fork of the road half a mile beyond Yellow creek. Half way up the hill from this, a bed of silicious *ore* was seen, 2 inches thick and enclosed in shale containing *Orthis*, *Leptocælia* and *Streptorhynchus*. Thence to the top of the hill, the shales are exposed, the red beds being reached at the hill top, beyond which one comes at once to the Lower Helderberg. Oriskany sandstone is shown at a little way east, forming the crest of the insignificant Warrior ridge.

Here one is on the east side of Coot mountain, which retains its name to Raver's creek, beyond which it is again known as Tussey mountain. The crest is notched owing to the irregular erosion of the white Medina. The dense forest covering its side prevents exact determination of the limits of the Clinton group. Following the road northward one rides on Lower Helderberg almost to the township line.

The Red ridge runs nearly parallel with the road, its rocks dipping at 50 degrees, while the Lower Helderberg beds have a dip of 60 degrees. Warrior ridge is a line of low knobs capped by Oriskany sandstone.

The Clinton ore was opened on S. Weimer's property by the Cambria Iron Company, but, when visited, the work had been idle for some time and no measurements could be made. Since that time, however, this important mine has been leased and re-opened by the Kemble Coal and Iron Company. Both *brown hematite* and *fossil* ore occur here, and samples were taken from the dump. These have been analyzed by Mr. A. S. McCreath, who gives the following as the composition of the ore:

Fossil Ore from Cambria Mine.

Metallic iron,	55.425
Sulphur,	0.018
Phosphorus,	0.229
Insoluble residue,	5.740

The Lower Helderberg is exposed in Weimer's gap through Warrior ridge, where it dips eastwardly at 65 degrees, and the Oriskany comes down to the road almost directly opposite to Mr. Weimer's house. Within a few rods, one passes into

Liberty township.

No exposures occur within the valley in this township south from Raver's creek, the whole space being covered by dense forest. On this creek, the Oriskany is reached below the first house and the Red ridge is just beyond the house. The white Medina is shown at the first bridge over the stream, where the dip is eastward at 47 degrees. The bottom of this rock is reached at the next bridge and thence to the forks of the creek, the road is in the lower Medina, while the Hudson rocks are reached in the open valley beyond. The rocks dip eastwardly until the bend in the road at say 60 rods north-west from S. Stonerook's house, where the crest of an anticlinal is crossed. The outcrop of the Coot mountain Medina is shown at somewhat more than 2 miles south from Mr. Stonerook's house. Exposures are

extremely bad beyond the crest of the anticlinal to the summit of the mountain at the township line, and everything is concealed for the last half mile by a dense thicket of scrub oak and pines. The only guide to the character of the rocks is found in fragments occasionally shown in the road.

At about a mile north from Raver's creek the valley is again open. The Red ridge is from 30 to 70 rods west from the road, which lies in the Lower Helderberg until it approaches the Cypher School-house, where it rises on the Oriskany sandstone. The limestone has been opened for local use at several localities and it is quarried for shipment by the Kemble Coal and Iron Company near Cove station, within a few rods of the Huntingdon county line. The upper beds of the group are not exposed at these quarries, there being a concealed interval of 50 feet. 50 feet lower is a bed of gray semi-crystalline limestone which is quarried. A blue, fine-grained limestone, streaked with calcspar and breaking with conchoidal fracture, underlies the gray limestone and is quarried. The total thickness quarried is about 20 feet. A sample of the gray limestone was sent to Mr. A. S. McCreath for analysis. Its composition is:

Limestone of No. VI from Quarry of Kemble Company.

Carbonate of lime,	96.592
Carbonate of magnesia,	2.459
Oxide of iron and alumina,	0.240
Sulphur,	0.019
Phosphorus,	0.008
Insoluble residue,	0.930
Total,	<u>100.248</u>

Immediately underlying the quarry is a blue flaggy limestone, the flags from 1 to 11 inches thick. This rock contains much calcspar and few fossils. It is shown to the thickness of about 30 feet and dips S. 70° E. at 40 degrees.

The Clinton ore has been opened by Mr. Robert Hare Powel on the Stoler property as well as at Cove station. The opening at the former place was merely an experimental tunnel, reaching the ore at 90 feet below the outcrop. It is not worked. The section reported from this tunnel is

Brown hematite,	2'
Sandstone,	1' 6" to 1'
Fossil and brown hematite,	2' 8"

The upper bed was carefully sampled by Mr. Edward McHugh, general superintendent of the Powel coal and iron mines, and the sample was analyzed by Mr. J. B. Britton with the following result:

Clinton Ore from Stoler farm.

Oxygen with the iron,	25.60
Water,	11.20
Silica,	2.96
Sulphur,	0.00
Phosphoric acid,	0.64
Alumina,	1.15
Lime,	0.20
Magnesia,	0.00
Undetermined matter and loss,	0.13
Metallic iron,	58.12

The operations near Cove station are much more extensive and the openings have been pushed with vigor as this is to an important source of supply for the fine furnace which is in course of erection by Mr. Powel near Saxton. A tunnel, 822 feet long, reaches the ore at 240 feet below the outcrop. The bed is double here as elsewhere but the upper or *brown hematite* division is irregular. The lower division consists of *brown hematite* and *fossil* and varies from 20 to 24 inches. It is mostly a soft fine-grained fossil with the fossils indistinct. It carries not a little specular ore and shows many flecks of decomposed shale. A sample taken at 60 feet from the outcrop and analyzed by Prof. F. A. Genth has the following composition:

Fossil Ore from Cove station.

Oxygen with the iron,	17.91
Water,	4.24
Silicic acid,	23.48
Sulphur,	0.00
Phosphoric acid,	merest trace.
Alumina,	12.09
Lime,	0.25
Magnesia,	0.23
Metallic iron,	41.80

Another sample, more carefully chosen so as to represent the fair average of the bed from top to bottom, was selected by Prof. Prime and sent to Prof. T. M. Drown for analysis. This showed

Metallic iron,	44.36
Phosphorus,	0.23

A *brown hematite* bed was cut by the Cove tunnel at 35 feet above the *fossil* bed, but no development has been made. As shown in the tunnel it is from 2 to 4 feet thick ; according to Mr. Britton's analysis it contains

Metallic iron,	51.42
Phosphorus,	0.32
Sulphur,	0.00
Silica,	9.98
Alumina,	3.24

CHAPTER X.

The region between Warrior ridge and the Fulton county line.

Topographically this is a separate area. Warrior ridge is distinct as one goes from the State line northward until Liberty township is reached, where for a short distance it is obscured by erosion and by the disappearance of Black valley. From the State line to the northern edge of East Providence township, the eastern boundary is marked by the bold Pocono ridge known as Ray's or Town hill; but this breaks down on entering Broad Top township and thence to the line of Huntingdon county the eastern boundary is indistinct, being the divide between the waters of Little Aughwick and of those streams flowing into the Raystown Branch of the Juniata.

The plications occurring within this area have not been without effect on the topography. The great strength of the anticlinals and the depth of the synclinals are shown by the elevated ridges in the southern part of the area, where all the streams flow southwardly in deep gorges bordered by ridges of Chemung. Further north in the Providence townships, the surface is far from being so abrupt, though the streams entering the Juniata in its deep gorge have eroded almost equally deep gorges for themselves.

No rocks newer than Chemung occur in the southern part of the area except in the Clearville synclinal and along the foot of Town or Ray's hill, where Catskill is the surface group. But the flattening of the axes northward carries the Chemung under before the Juniata is reached, so that aside from strips of Chemung, Hamilton and Oriskany lying east

(203 T².)

from Warrior ridge, the whole area is covered with Catskill to the southern edge of Broad Top township. There the Catskill disappears in its turn and is succeeded by the Pocono, which forms the crest of the bold Terrace or Harbor mountain. Northward from this ridge, the Mauch Chunk and Pottsville appear in succession and then disappear to be succeeded by the Coal Measures which cover a great part of Broad Top township.

This area embraces the whole of Mann, East Providence and Broad Top townships, with parts of Southampton, Monroe, West Providence, Hopewell and Liberty townships.

Entering

Southampton township

from the south at the east foot of Warrior ridge, one finds himself on Hamilton shales. The ridge is broken by three gaps within Southampton township, one at the State line, the second at McLewees' mill and the third near Cheneyville, opposite Sweet Root gap in Tussey mountain. The Lower Helderberg, forming the body of the ridge, is fairly well shown at several localities, but for the most part no details can be obtained. The Oriskany is imperfectly exposed at the mouth of McLewees' gap, where its dip is not far from 30 degrees. It is somewhat better shown at the gap near Cheneyville, where much of it is snow-white. *Brown hematite* frequently occurs in the upper part of this sandstone or at the base of the Hamilton, and digging for the ore has been done at several places along the foot of the ridge. But, as the pits have all been filled with débris, one cannot determine with absolute certainty even the position of the ore. *Bog ore* was seen in large quantity at a little way north from McLewees' gap as well as on the farm of J. H. P. Adams, at a mile north from Cheneyville.

The Marcellus black shales rest directly on the Oriskany and at some places they show streaks of the blue to brownish blue limestone belonging at that horizon. The shales are very dark and they have been prospected for *coal* at more than one locality. They are best shown on the road leading from Cheneyville into Black valley. The middle

shales of the Hamilton are exposed at many places along Town creek. These are laminated sandstones, in beds of from 8 to 10 feet thick, separated by drab to bluish hard shales, and the whole mass is known locally as the gray shales. They are exposed in the village of Cheneyville.

Eastward from McLewees' gap, these shales continue until nearly 20 rods beyond the bridge over Town creek, and they are well exposed in a bluff where the Cheneyville anticlinal is cut by the stream. The Genesee shales were not clearly recognized along this line and the gray Hamilton shales pass upward into laminated brown to olive shales which dip E. S. E. at 45 to 50 degrees. These, which may be regarded as Portage, pass into dull slate-colored more or less fissile shales, which continue to near the crest of Polish mountain, becoming lighter near the crest, where they are mostly yellow. A well-defined bench of these shales is shown along the west side of Polish mountain. Fragments of the *Chemung Conglomerate* lie plentifully along the crest of the ridge, but none was seen in place.

Crossing the ridge, one descends into a narrow valley between that and Ragged ridge, in which the yellowish shales prevail. There is some possibility that the conglomerate seen on the crest of Polish mountain may belong to the lower one, as the shales seen in the valley bear little resemblance to those overlying the *Upper Conglomerate*; and, moreover, contain many layers with *Ambocoelia gregaria* and impressions of *crinoid* stems, such as ordinarily characterize the shales holding the *Lower Conglomerate*. A ridge ends in this valley at a little way north from the old Elbinsville post-office, which carries some fragments most probably belonging to the *Upper Conglomerate*. No trace of the Catskill was observed here and that group terminates in the ridge just referred to.

The axis of the Clearfield synclinal passes very near the old Elbinsville post-office and the dip beyond that place is distinctly westward. In ascending Ragged ridge the yellow and variegated shales are occasionally exposed and a coarse sandstone is shown at the crest with fragments of conglomerate resting on it. This ridge and Polish mountain come

together at or just beyond the State line and they evidently owe their existence to the protecting influence of the conglomerate.

In descending Ragged ridge eastward, no exposures were seen aside from those of sandstones which belong within 500 feet below the conglomerate. Turning eastward at the first fork of the road, one enters a wooded area in which are no exposures; but at somewhat more than two thirds of a mile west from Fifteen-Mile creek, an exposure shows that the dip has been reversed for the rocks are dipping eastward sharply. This is the Sheaver's creek axis. The Snyder's ridge synclinal is crossed by the creek near the church and school-house. Between that place and W. P. Lashley's store, one crosses the southern part of Snyder's ridge, which terminates in a bold knob known as Huff's Knob, rising almost to the same height with Tussey mountain. Only Chemung rocks are shown between Fifteen-Mile creek and Lashley's store, but they are very badly contorted, there being at least three anticlinals with some indications of a fourth, though the distance is little more than one mile. These are the folds of the Snyder's ridge anticlinal. There is every probability that the *Upper Conglomerate* still remains on top of Huff's Knob, though no indication of its presence could be found aside from the scattered fragments.

Going north-eastward from W. P. Lashley's store, one finds occasional exposures of Chemung rocks and crosses the Felten synclinal at not far from J. Murphy's house. A sharp anticlinal succeeded by a narrow sharp synclinal is shown at the first Wigfield house, and a strong anticlinal was seen where the road crosses a branch of Piney creek. These represent the Broad Top anticlinal. Thence few exposures were found until the crest of Addison ridge was reached at the sharp bend of the road south from School-house, No. 9, where the *upper conglomerate* of the Chemung is shown. The Catskill appears within barely one fifth of a mile further and thence to the county line in Leasure's gap, only rocks of that period are exposed. The succession is shown indifferently and one cannot discover whether or not

there are any folds in the rocks. The Pocono is not present at the top of Town hill near the gap, but is caught by the ridge at a little way both north and south from the gap. The ridge here is a synclinal, the southern termination of the Emmaville trough.

It is barely possible that some Hamilton is brought up on Fifteen-Mile creek near the State line, but the exposures do not suffice for satisfactory determination of the matter.

Going north-eastward along Piney creek one finds no good exposures after passing Addison ridge until somewhat more than a mile above Morse's store. Not one of the anticlinals observed along the southern line was seen, but a synclinal is shown at the fork of the creek near Mrs. Leasure's house, which may be the Felten synclinal, but is more likely to be one of the subordinate troughs of the Snyder's ridge anticlinal. Chemung rocks are exposed imperfectly at many places along the creek, but nowhere in detail. Turning westward at Mrs. Leasure's and ascending Snyder's ridge one comes at once to the group of anticlinals indicated as the Snyder's Ridge anticlinal. Five distinct folds were seen before reaching G. Coonrod's house, in a distance of little more than one mile. The Snyder's Ridge synclinal passes just west from Coonrod's house and the great *conglomerate* is caught at the top of Snyder's ridge. Chemung rocks are imperfectly shown here and there between Coonrod's and the top of the ridge at T. Kinzer's house. Thence exposures are very poor, but the Sheaver's creek anticlinal passes very near to where the road crosses Wilson's run and thence the rocks dip sharply westward in the great Clearville trough. The *Chemung conglomerate* comes down and passes under the run and the Catskill is reached at the first little stream entering from the north. The upper Chemung and the Catskill make up the short abrupt mountain known as Ward's ridge. The Chemung conglomerates are not shown in place on the east side of the trough though their fragments are scattered abundantly over the surface. The Catskill rocks consist almost wholly of laminated sandstones, red, hard, and micaceous. The base of the Catskill is easily determined within a few feet

on the west side of the trough; for a mass of red and yellow shales marking the top of the Chemung is well exposed where the road turns sharply southward and leaves Wilson's run to cross a high point. The *Chemung conglomerate* reached at about eighty rods further west near M. Cooper's house. The axis of the Clearville synclinal is crossed by Wilson's run at about midway between H. Ruby's house and School-house, No. 5.

Exposures thence are indifferent until one comes to Cheneyville, where Hamilton rocks are reached. The Cheneyville anticlinal passes through the eastern edge of the village and the dip is westward at the church in the village. The synclinal passes through the village, so that at the western side the dip is distinctly eastward and the middle or sandy shales of the Hamilton are well exposed at several places in the village. The Marcellus shales are shown between the village and Warrior ridge, while the Oriskany sandstone is shown imperfectly on the east side of that ridge.

Going northward from Cheneyville, one rides amid the "gray shales" of the Hamilton. A group of white sulphur springs were seen at nearly a mile north from Cheneyville. These have a considerable local reputation as possessing important curative properties. The quantity of water escaping is not great. Within a short distance beyond the Sulphur springs one passes into

Monroe township.

The road gradually approaches Warrior ridge until it is at its foot at O'Neal's mill. The *ore* overlying the Oriskany sandstone is present at several places, but no attempt has been made to ascertain the quantity. The Marcellus shales are shown at O'Neal's mill where they reach well up the side of the ridge. The Oriskany is crossed by the road just beyond the long bend, where it is grayish white, massive, coarse-grained, and contains some pockets of conglomerate. It forms a bold wall on the east side of the road and continues to the top of the ridge, where the Lower Helderberg is exposed.

Returning to O'Neal's and taking the road eastward toward Clear ridge, one finds the Hamilton rocks fairly exposed until near the top of Milk and Water ridge, where the Portage (?) beds are reached. These consist almost wholly of olive shales and sandstones, by which the ridge is formed. The Chemung beds outcrop on the eastern side of the ridge and thence to the crest of Clear ridge the variegated shales of this group are frequently shown in low cuts alongside of the road. The presence of the conglomerate on the crest of Clear ridge is proved by loose fragments, but the rock was not seen in place. The dip in Clear ridge is eastward at from 55 to 60 degrees.

The Clear Ridge anticlinal was not recognized here, there being no exposures from the west side of Clear ridge until J. Barkman's house is reached, a distance of nearly two miles. An imperfect exposure near J. Fletcher's, one third of a mile west from Barkman's, shows the dip to be westward, so that the axis of the Clearville synclinal has been crossed before that house is reached. The dip is westward at Barkman's. The *Chemung conglomerate* is exposed imperfectly at the cross-roads just east from Barkman's house and the variegated shales underlying that rock are shown in the road further east. The Sheaver's Creek anticlinal is crossed by the road at the head of Chapman's run and the shales dip eastward near H. Mills' house.

After crossing Chapman's run, one begins to ascend Snyder's ridge. The exposures are very poor and the axes composing the Snyder's Ridge anticlinal could not be made out satisfactorily. The *Chemung conglomerate* is caught at the summit of the ridge and covers the plain on which D. Mills' farm is situated. The Snyder's Ridge synclinal is crossed by the road very near that house, for in descending the east side of the ridge a westward dip is distinct. A sharp anticlinal passes very near C. Croghan's house, barely 50 rods from Piney creek, which is the only member of the Snyder's Ridge anticlinal shown along this line. Exposures are continuous along Piney creek southward to the township line, but they exhibit only variegated shales until near the

line, where brown sandstones belonging to the lower part of the Chemung are exposed.

Leaving Piney creek and ascending Raccoon ridge, one finds frequent exposures of Chemung variegated shales, with an easterly dip of 55 degrees. The *lower conglomerate* is shown in the variegated shales at a few rods below the summit of the ridge, but thence exposures become very poor. Fragments of conglomerate occur on top of Raccoon ridge, so that there is no reason to doubt that the high ridges, Raccoon and Hoop-Pole, catch the *upper conglomerate* further south. The easterly dip continues to beyond the crest of the ridge, but the Felten synclinal is crossed before one comes to the fork of the road, and in Hoop-Pole the dip is westward. Fragments of the *upper conglomerate* are numerous along the road following the east side of Hoop-Pole and some of the variegated shales belonging to the Chemung are highly fossiliferous at one third of a mile south from John Ray's house. The dip here is distinctly westward.

In descending Hoop-Pole toward Sideling creek, one finds no exposures; but almost immediately beyond the creek, imperfect exposures show an eastward dip. The axis of the Broad Top anticlinal crosses very near the stream. Fair exposures of Chemung shales occur near C. Keel's house at the west foot of Addison ridge, and dark shale near that house has deceived some into searching for *coal*. The shales and sandstone flags on this side of Addison ridge are fossiliferous. The *upper conglomerate* is exposed in the gap by which the road passes through Addison ridge, where, for the most part, it is a moderately coarse sandstone with layers of conglomerate in which are geodes lined with crystals of quartz. Much of the rock is ferruginous and nodules of *brown hematite* are common. The thickness here cannot exceed 40 feet. Above this rock are brownish to yellowish gray and red shales extending to Robinsonville. Thence to the county line along the Hancock road only Catskill rocks are shown. These are red to brown sandstones alternating with red shale. The dip is irregular, from 20 to 70 degrees eastward; but the exposures are not complete and the presence of flexures could not be ascertained. The

Hancock road passes through a wind gap in which the Pocono is wanting, its outcrop lying in Fulton county. But that rock forms the crest of the ridge southward almost to Leasure's gap and northward to Brush Creek gap at Gapsville.

Pyrolusite of excellent quality occurs along with *brown hematite* in fragments plentifully scattered over the surface on the west side of Ray's hill, near Robinsonville. These fragments were followed up the mountain's side to within 20 rods horizontal distance from the summit but their place was not found. They belong to the Pocono. The *hematite* is frequently attached to sandstone such as never occurs in the Mauch Chunk and the fragments of *pyrolusite* sometimes show imprints of conglomerate such as occurs only in the Pocono.

Going northward along Addison ridge, one rides constantly within a few yards of the outcrop of the *Chemung conglomerate*, while Catskill beds form a valley between that ridge and Ray's hill. At nearly six miles north from Robinsonville, a road turns westward and descends the ridge to the west branch of Sideling creek. Occasional exposures of the Chemung variegated shales are shown on this road between the crest and the creek. An anticlinal is crossed very near the creek and another near A. Messersmith's house. The dips of the latter axis are very sharp on the west side, being almost vertical near T. Mellott's house and 70 to 75 degrees near Messersmith's house. These represent the double axis of Broad Top.

The top of Hoop-Pole ridge is reached at a little way above A. Messersmith's house. There the rocks are dipping westwardly, the ridge being the western slope of the Broad Top anticlinal. Only Chemung rocks are brought up under this axis, the exposures reaching barely to the Portage (?). Exposures are few on the west side of Hoop-Pole ridge but slabs of sandstone with Chemung fossils lie scattered over the surface and occasionally one sees some brown or red shales. The Chemung *upper conglomerate* occurs near the top of the ridge. The Felten synclinal must pass very near the sharp curve in the road near A. Pennel's house, half a

mile north from the Nycum School-house, for at a run just north from the school-house, the easterly dip is well shown. Chemung rocks are shown imperfectly near the school-house, where they consist for the most part of flaggy sandstones covered with *Sanguinolites*. No further exposures were found until the same run was crossed again on the road to Clearville at nearly two thirds of a mile from Nycum's School-house.

Leaving this run, one ascends Raccoon ridge and in so doing comes upon the Snyder's ridge group of anticlinals. These are shown partially near B. Pennel's house, where the yellow and variegated shales of the Chemung are exposed at the roadside. A coarse conglomerate is shown on the west side of the ridge and continues thence almost to Logue's mill on Sheaver's creek. This makes the ridge and it may be the *upper conglomerate*; but its relations were not determined satisfactorily, as the exposures are very bad. The Snyder's ridge synclinal passes at but a little way beyond Logue's mill on Sheaver's creek, and the Sheaver's creek anticlinal is reached very near W. Amick's house at a mile and a half east from Clearville.

The axis brings up only the Chemung. The *upper conglomerate* of that group is reached near J. Grub's house where it forms Black Oak ridge, just as near the southern border of the township it forms Ward's ridge. The red and yellow shales at the top of the Chemung are shown very near Clearville and that village stands on the Catskill beds. These continue until a few rods beyond the church and School-house west from the village, where one comes again to the red and yellow shales of the Chemung.

Sandstones with *Spirifera disjuncta* and other Chemung forms are exposed at the forks of the Black Valley road, barely one third of a mile west from Clearville. As far as observed, the dip is eastward to the crest of Clear ridge. That ridge is divided longitudinally and the *Chemung conglomerate* forms the crest of the eastern division. Occasional exposures of Chemung were found in the valley of Clear creek but they are not continuous and the Clear Ridge anticlinal was not detected. The two forks of Clear creek

make a broad "bottom" in which all is concealed. Ascending Milk and Water ridge, one finds shales and flaggy sandstones, the former mostly olive and breaking with a conchoidal fracture. These continue to the summit, where the laminated sandstones of the Hamilton are reached, the Genesee shales being, to all appearance absent. The Hamilton sandstones form the backbone of the ridge and the Marcellus shales are fairly well exposed on the west side as one descends to a fork of Clear creek flowing along the foot of Warrior ridge. The dark shales continue across the stream and into the gap through Warrior ridge, above Steckman's mill. There the ridge is broken down and the Oriskany sandstone is reached only after one has passed through the gap.

The Clear Ridge road soon passes beyond the *Chemung conglomerate*, but owing to the increasing height of the ridge northward, that rock soon touches the road again and huge fragments of it lie scattered over the surface. Within two miles from Clearville, the road passes into

West Providence township

and thence to the forks, somewhat more than a mile south from Sparks' School-house, it lies immediately west from the outcrop of the *conglomerate*. Turning eastward at the first fork north from the township line, one comes at once to the Clear Ridge synclinal, which is well shown in the road at a few rods from the summit, while the Clear Ridge anticlinal is distinct at the first sharp bend, say fifty rods from the ridge road. The *conglomerate* is here and its fragments lie thickly strewn over the surface. The red and yellow shales marking the summit of the Chemung are shown immediately above Miss Calhoun's house and there one comes to the Catskill beds. The Clearville synclinal is crossed before reaching Grey's run, but the Catskill beds continue beyond the run to midway between the Clark School-house and H. O'Neal's house. The Grey's Run anticlinal is shown just west from Mr. O'Neal's house, but, at the house, the dip is westward and the yellow shales underlying the *conglomerate* are imperfectly exposed. Occa-

sional exposures of brown and red shales occur for half a mile beyond this and in each case the dip is westward. Fragments of conglomerate are scattered over the surface, but they are small and show evidence of having been subjected to long weathering. Owing to lack of exposures, the relations of this conglomerate could not be ascertained, though its position indicates that it belongs to the *lower* bed. The Sheaver's Creek anticlinal passes near Pittman's fork in the road, but its place was not fixed, as the surface has been planed off smoothly and affords no exposure for one third of a mile on either side of that point.

There are no good exposures from Pittman's until near A. Clark's house, where the variegated shales of the Chemung contain slabs of sandstone with *Spirifera disjuncta* and other forms not well enough preserved for identification. The dip at this locality is eastward. No further exposures were found on or near this road until Sheaver's creek was reached on the border between West Providence and Monroe townships, where the Chemung rocks are dipping westward at 40 degrees. The Snyder's Ridge group of anticlinals is not exposed along this line, but it should pass through the south-east corner of West Providence township and the Felten synclinal should be crossed at or just east from the line of West Providence. The road which we have followed passes for a few rods through Monroe township and then enters

East Providence township

at its extreme south-west corner. In Monroe, the Chemung sandstones are shown containing *Rhynchonella contracta* and other forms. No exposures occur in East Providence between the creek and the first fork of the road. Fragments of *Chemung conglomerate* are scattered more or less plentifully over the surface, but the Catskill has been eroded from this valley of Sheaver's creek and the conglomerate was only doubtfully present, though it occurs in this Felten trough further south in both Monroe and Southampton along the high Hoop-Pole and Raccoon ridges. There is, however, in this vicinity at least, a decided southward rise in

the rocks for, on a branch of Sheaver's creek, one mile north from this road, Catskill rocks are shown, beginning just above Strait's mill, where the dip is westward at 55 degrees. A good exposure of the red shales is seen on the north side of the stream at the mill, with dip of 60 degrees westward. The Felten synclinal is reached at the fork of the road nearly a mile below the mill and the Catskill rocks pass beyond Sheaver's creek into West Providence township.

Turning southward at the cross-roads near R. Zigel's house, no exposure was found aside from partial exhibitions of the variegated Chemung shales until the fork of the road, where some flaggy sandstone was seen dipping eastward, and at the cross-roads, one fourth of a mile east from Cherry Grove, the *Chemung conglomerate* was seen dipping eastward. Here, on the summit of Addison ridge, the rock is somewhat fossiliferous and ferruginous. It is largely conglomerate and the pebbles vary in size from pea to chestnut. The fossils are obscure, having been replaced with limonite. *Palaeoneilo* and *Ambocoelia* were recognized, but the other forms are too indefinite for determination. Chemung rocks are shown occasionally on the east side of the ridge until beyond C. Felten's house. Thence there are no exposures aside from fragmentary exhibitions of Catskill red shale and laminated red sandstone until one comes to the top of Ray's hill. At the foot of that ridge, near C. Rice's house, the road turns northward towards Gapsville. It affords no exposures; débris from the Pocono covers the west slope of the ridge and effectually conceals everything.

Brush creek breaks through Ray's hill at Gapsville and gives fairly good exposures of the upper part of the Catskill, which there consists almost wholly of red shales. Going westward along this stream, one rides on Catskill to its mouth. The Everett road, which leaves the creek at somewhat less than a mile below Gapsville, does not reach the Chemung beds until it passes beyond the crest of Addison ridge, where the Broad Top anticlinal carries the Chemung northward beyond Brush creek. But before the creek is reached at Felten's mill, the road is again in the Catskill,

blood red shales with dull reddish brown laminated sandstones on which light colored lichens seem to flourish. The Catskill rocks are well exposed between Felten's mill and Williams' mill, the latter on the line between East and West Providence townships. Crossing Brush creek here, one comes into

West Providence township

and ascends the ridge to Mench's store. No exposures were found until very near the store, where Chemung belonging below the *conglomerate* was found. *Spirifera disjuncta* and a *Chonetes* were seen, but the other forms could not be made out. The strong Sheaver's creek anticlinal passes near the store and Catskill on its western side is reached at less than half a mile from Mench's store; good exposures were seen near J. Zembower's house. These rocks continue almost to the summit of Clear ridge, where the Chemung conglomerate occurs in fragments, but is not shown in place.

Exposures are few on the west side of Clear ridge, but many fragments of flaggy sandstone were seen, carrying *Atrypa aspera* and *Streptorhynchus chemungensis*. Brown sandstones are shown at Clear creek, dipping S. 40° E. mag. at 55 degrees. Beyond these to Dr. Miller's house are yellow more or less fissile shales; below which are olive shales and flags, well shown in the river bank, where they are badly distorted. The Chemung series end at the bend in the road west from Dr. Miller's house, and beyond that to the foot of Warrior ridge occasional exposures of Hamilton were seen. Only the lowest division of the group is shown and it is thrown into several short folds near the fork of the road just east from the ridge.

Iron ore was digged at one time on the Barndoller and Baughman place at the foot of Warrior ridge about a mile south from the Juniata. It is a *brown hematite* belonging at the top of the Oriskany or at the base of the Marcellus. As the pits have long been filled with rubbish, the exact relations of the ore could not be ascertained. Samples were analyzed by Mr. A. S. McCreath with the following result:

Barndoller and Baughman ore.

Metallic iron,	53.050
Sulphur,	0.056
Phosphorus,	0.087
Insoluble residue,	7.800

If the average quality of the ore should approach that of the specimens analyzed, this mine would certainly be well worth working.

At the foot of Warrior ridge one crosses the river to Everett and reaches the Bedford and Chambersburg pike. This road follows the Juniata river to its sharp northward bend, somewhat more than a mile beyond the eastern border of West Providence township; its numerous long and deep side-cuttings exhibit very clearly the structure of the region between Clear ridge and Ray's hill, the eastern boundary of the county.

In the immediate vicinity of Everett, east from Warrior ridge, exposures are far from being continuous. The Marcellus shale is fairly well exposed near Barndoller's tannery where it rests on the Oriskany sandstone and carries a narrow yellow streak of ferruginous shale. The middle division of the Hamilton and the Genesee shale were not seen; the olive beds of the lower Chemung are exposed at the eastern end of the village where the dips vary from 25 to 55 degrees. The conditions in the borough of Everett could not be ascertained; it may be that the lower beds of the Chemung occur there also. East from Everett, at Cemetery hill, the rocks are badly twisted and the shales describe some very complicated short folds. These shales are brown to olive, more or less fissile and hold flags of slightly ferruginous sandstone, 2 to 11 inches thick. An additional fold was observed near the toll-gate somewhat more than half a mile north from the cemetery. Thence are no good exposures until beyond I. Richey's house, where, in a cut, the highest beds of the Chemung are shown dipping eastward at from 70 to 90 degrees. These are light reddish-brown with indistinct bedding and are somewhat micaceous. Fragments of the *upper conglomerate* are strewn over the surface at Mr. Richey's house. Before reaching the fork of the road

east from that house, one has passed the Chemung and entered the Catskill. Exposures are indifferent thence until, at Mr. Morgart's house, the rocks are shown dipping westward. The western division of the Clearville synclinal evidently crosses near the fork of the road at B. Hughes' house. Thence eastward to the county line, one rides in Catskill rocks, which are finely exposed in the deep gorge by which the river flows through the successive ridges. The rock is for the most part a reddish-brown sandstone, varying from laminated to massive, in beds from 5 to 30 feet thick, alternating with beds of dark brown to bright red shale, from 2 to 15 feet thick.

After passing Morgart's place, the Grey's Run anticlinal is reached within 100 yards of the old toll-gate, where it is broad and gentle. The eastern division of the Clearville synclinal is crossed at the old toll-gate. The axis of the Sheaver's Creek anticlinal is reached at the bend just below J. P. Weaverling's house, while the western division of the Snyder's Ridge synclinal is at the river bend below that house. Between this and the township line, the anticlinal which splits the Snyder's Ridge synclinal is shown, while the east division of the synclinal is passed within a few rods of the township line. Here one enters

East Providence township

and before reaching the river crossings, passes five gentle anticlinals, representing the complex Snyder's Ridge anticlinal. The deep Felten synclinal is crossed at, say, 100 rods west from the river bridge, and thence the rocks rise on the side of the Broad Top anticlinal to McGraw's peach orchard, at somewhat more than a mile and a half from the river crossings, by the road. The dip thence is very irregular, three well-defined folds having been observed within the next mile. Exposures become indefinite beyond the tannery, and the Pocono sandstone is reached at, say, half way between the last fork of the road and the top of the hill.

Leaving the pike at the tannery, the old Fairview post-office, and going northward towards the Lutheran church,

one finds only rare exposures of Catskill shales and sandstones, dipping eastward until the Nycum School-house. There the dip is reversed and, at the angle in the road opposite J. Naugle's house, some gray sandstone, more or less conglomerate, is shown in fragments scattered over the surface. The region is very high and in all probability these fragments are remnants of the Pocono sandstone, which at one time extended over this region. With these are some variegated shales. The westerly dip is distinct at the Lutheran church.

Exposures are very poor on the road leading westward from the Lutheran church past the Reformed church and are insufficient for proper working out of the structure. A synclinal is crossed about midway between the two churches and an anticlinal must pass very near the Methodist Episcopal church, for, at the Reformed church, the Pocono gray sandstone is in place and dipping westward. Near Mr. Grove's house, half a mile further west, the dip is eastward and the exposed rocks belong to the Catskill. Rocks of this group prevail thence to the river, but the dip changes again to the west. Before reaching the river one comes again into

West Providence township

at the Union School-house. Few good exposures were found beyond the river, and only Catskill rocks are shown to the Chambersburg pike, which is reached at B. Hughes' house.

A road follows the east side of Warrior ridge from Everett to Tatesville in Hopewell township. The Oriskany sandstone is fairly well shown at several places along this road, but the rock is very soft and breaks down so readily that it is seldom seen in place. The gap of John's run, a small stream breaking through Warrior ridge at Tatesville, exhibits the upper part of the sandstone and shows it to be soft, more or less conglomerate. The Marcellus shales, imperfectly shown at several places along the road, contain the blue non-fossiliferous limestone. Crossing to the north side of John's branch or run, one comes into

Hopewell township

at Tatesville. The end of the Hamilton beds on this run is just above W. D. Ritchey's house, and the Portage (?) flags and shales are shown directly beyond the first long trestle, where the dip is eastward at 60 degrees. Thence exposures are fragmentary until as one approaches the old tannery he comes to the *Chemung conglomerate*, which makes the first bold ridge east from Tatesville. A narrow valley intervenes between this and the bolder ridge formed of the Catskill sandstones and shales, whose west foot is at 2 or 3 rods below the old tannery. Crossing the run there, the road passes again into

West Providence township.

The Catskill sandstones are shown immediately below the tannery where their dip is 28 degrees, S. 60° E. The dip at the river is very nearly the same and a fine exposure of the series is given in the great bend of that stream. The group consists of alternating beds of sandstone and shale, the latter frequently bright red, while the former are mostly brownish red and laminated, the layers varying in thickness from one fourth to one half inch. The easterly dip continues to the ford below W. Osborn's house, where the Clear Ridge synclinal is crossed. A short abrupt anticlinal, the Clear Ridge, is cut by the river at Mr. Osborn's house, showing a dip of 50 degrees on the westerly side and of 35 degrees on the easterly side. A narrow synclinal, the western division of the Clearville, lies beyond this. At the mouth of French's run, where one passes into

East Providence township,

a bold anticlinal, the Grey's run, is cut by the river. A long point of Pocono, known as French's knob, extends southward in the Clearville synclinal and overlooks the river. The outcrop of Pocono, which forms the crest of Terrace or Harbor mountain separating East Providence from Broad Top township, is bent northward on the Grey's Run anticlinal, but re-curves southward in the eastern division of the Clearfield trough. Exposures are not contin-

uous along French's run, but two distinct folds were seen before the forks of the stream were reached. Thence to the head of the run, only Catskill rocks occur in the valley. These make a well-defined bench on the south side of Harbor mountain, curving round at the head of the cove, where the mountain bends southward and becomes Ray's hill.

A road leading from the Ray's hill tannery on the Chambersburg pike crosses French's run above the forks of the stream and leads thence across the mountain into

Broad Top township.

The Pocono is reached on this road just above H. Weicht's house in East Providence; but the exposures are very indefinite on the south side of the mountain. They are little better on the north side, where the road descends into the valley of Sherman's run. But for more than two thirds of a mile in descending, the road follows an anticlinal, evidently that seen at the mouth of French's run; further down it turns westward and reaches the Mauch Chunk very near Sherman's run, which it touches at barely one third of a mile above Ford's mill. The shales are shown at that mill, but the stream breaks through them at a short distance further down and soon reaches the river. Its valley touches the Pottsville ridge which forms the western boundary of the Broad Top coal field.

Sherman's or Ground Hog valley is eroded from the Mauch Chunk shales and is enclosed by the Pocono ridge at the south and west, and by the Pottsville ridge at the north. It is continuous northward with the valley followed by the Juniata and eastward with the broad Mauch Chunk valley forming much of Wells township in Fulton county.

Turning westward where the road first strikes the run, one finds a point of Pocono sandstone coming down quite to the stream just above Rinard's mills. Another point comes down to the run and crosses it immediately above J. Rinard's house. These are the Grey's Run and Sheaver's Creek anticlinals. A very shallow trough lies between the

latter and the next anticlinal, in which only the lowest beds of the Mauch Chunk pass south from the road. The Mauch Chunk *iron ore* has been mined by stripping about midway between the houses of J. Rinard and W. P. Young. The excavations cover several acres. The ore is *brown hematite*, 2 to 3 feet thick and the cover varies from 3 to 12 feet in the strippings. Several hundred tons were taken out and shipped to Johnstown, but the ore proved too cold-short. A sample was taken that was analyzed by Mr. A. S. McCreath with the following results :

Mauch Chunk iron ore from J. Rinard's farm.

Metallic iron,	41.450
Sulphur,	0.026
Phosphorus,	1.257
Insoluble residue,	16.340

The anticlinal immediately east from this does not bring the Pocono across the road. Thence the exposures are worthless for more than a mile, but the Pocono certainly touches the road near D. Lane's house, where fragments of that rock are numerous. The trough lying east from this anticlinal is deep, and Mauch Chunk shales lie well up on the mountain side, so that fragments of Pocono occur rarely on the bench directly above the road. Another axis was crossed at say half a mile above Mr. C. Scutehall's house, while just beyond the cross-roads near Mrs. Worsing's the side of a broad exposure of Pocono is reached, which marks the Broad Top anticlinal. This low ridge of Pocono forms the divide, and at its crest is Wishart's gap leading from the waters of Sherman's run to those of Sideling Hill creek. Along this axis the Pocono extends for a full one third mile north from the road. Descending the eastern side of the ridge, one soon comes to the Mauch Chunk shales which continue to the county line.

The southerly outcrop of the Pottsville conglomerate, forming the northerly edge of the valley is rudely notched by the several anticlinals, and the notch answering to the Snyder's Ridge and Broad Top anticlinals is deep and broad. On the east side of the latter the conglomerate outcrop

moves southwardly and crosses into Fulton county at less than one fourth of a mile north from the road.

Returning now to Ford's mill and descending the stream to the river one passes through the Mauch Chunk and before reaching the railroad touches the Catskill. Descending the river to Hopewell along the railroad, one finds occasional exposures of Pocono, Mauch Chunk and occasionally almost touches the Pottsville, which, above Hopewell, caps the hill overhanging the river. At Hopewell the railroad again reaches the Pocono and Allequippa mountain is cut by the river in the sharp bend at that place, while Yellow creek, flowing through Hopewell township makes a water gap through the mountain. For reasons given in a previous chapter, Allequippa mountain turns almost northward from French's knob, making an acute angle; its trend thence into Huntingdon county being nearly N. 30° E. The river breaks through the mountain at two miles below Riddlesburg.

Pocono underlies the village of Hopewell, where one may cross the river into

Hopewell township

at the mouth of Yellow creek. The succession is fairly well shown along this stream. Ascending the stream from its mouth, the following succession was made out:

Pocono.

1. Sandstone, dip 46 to 65 degrees, hor. expos. 920' . . . 736'

The average dip is not far from 53 degrees. This is the great sandstone at the top of the Pocono. It is well exposed along the grade of the Kemble Coal and Iron Company's narrow guage railway as that leaves the river. At 445' from the base, the dip varying thus far from 46 to 50 degrees, a mass of contorted rock is reached containing many films of *coal*, some irregular pockets of black shale, some of it very carbonaceous. Much of this portion, which in all is not far from 30' thick, is conglomerate. The rock is massive in the upper part but becomes flaggy and irregular below and finally somewhat shaly, so as to pass gradually into the underlying division. The *coal* of the middle portion becomes more distinct further south, and a well-marked *bed* of 3 to 4 inches thick has been found in the upper part on Geo. C. Gibson's farm, half a mile from the mouth of Yellow creek.

2. Shale, dip 46 to 48 degrees, hor. exp. 196', 140'
This contains irregular bands of sandstone and is fairly well shown on the railway grade, but rather better between the grade and the creek.
3. Sandstone, dip 45 degrees, hor. exp. 125', 87'
The top of this mass is shown on the south side of the creek and on the river, its base being 70' west from the end of the river bridge. The character of the rock is well shown along the path following the river bank below the bridge. The rock is gray to blue, mostly very hard. Midway, it contains great numbers of plant stems, occasionally whole casts but usually only casts of the interior in sand, coated with *coal*; often the stems have been replaced by pyrites, occasionally by *brown hematite*. Films of *coal* are not rare and some of the beds are crowded with comminuted fragments of carbonized woody matter. Nests of *brown hematite* occur at various horizons in this rock, while at about 40 feet, horizontal distance, from the base are two beds of ferruginous conglomerate, which contain small lumps of hematite with larger fragments of red shale.
4. Shale and sandstone, dip 45 deg. Hor. exp. 101', 70'
These are shown alongside of the road between the bridge over the river and that over the creek. The sandstone lies at the bottom of the mass and so far as seen is but 5 feet thick. It is hard and bluish.
5. Concealed interval, 1129' hor. dist., 870'
This begins midway between the bridges. No exposures were found here or on the railroad grade following the north side of the valley. The bottom of the Pocono lies above the middle of this interval.

Catskill.

6. Sandstones, 53 to 58 deg. Hor. exp. 495', 400'
These make an almost continuous exposure on the south side of the creek up to the first road turning southward. Some thin beds of shale were seen, but they make a very small part of the mass. The sandstone is mostly laminated, some of it is dark red, but for the most part it is brownish or greyish-red and is covered with lichens. It is of irregular composition, for most of it shows a pitted or worm-eaten surface. The shales are blood red. These rocks have all the features of those which have been referred to the Catskill.
7. Shale and sandstone, dip 56 deg. Hor. exp. 690', 570'
These are shown on the railroad grade beginning at the cemetery directly opposite end of last exposure on south side of creek. Shales predominate at the top and for the most part are blood red; sandstones increase downwards, are laminated, brown with red cast and are soft. Many of the layers show the worm-eaten surface.

- | | |
|--|-------|
| 8. Imperfectly exposed, 120' hor. dist., | 97' |
| This interval contains much red shale. | |
| 9. Sandstone, dip 56 deg., | 15' |
| Laminated, somewhat micaceous, brown with red cast and pitted surface. | |
| 10. Concealed interval of | 20' |
| 11. Sandstone like No. 9, | 15' |
| 12. Concealed interval of 200' hor. dist., | 166' |
| 13. Sandstones and shales, 56 deg., hor. exp. 2047', | 1700' |
- This interval continues to within about 300' of the second bridge below Eichelbergertown, a small village nearly a mile and a half from the river. The exposure is by no means continuous, there being few exhibitions of shale. Sandstones in beds of 10' to 40' thick are shown at short intervals along the south bank of the creek, the concealed intervals being of about the same thickness. Here and there beds of red shale are shown, but for the most part the shales are concealed or very imperfectly exposed. The higher beds of sandstone are red to bluish, the former laminated and soft, the latter thin-bedded and grit like. Toward the base of the mass, gray sandstones appear, belonging to the Chemung; but the limit between Catskill and Chemung could not be determined

Chemung.

- | | |
|--|------|
| 14. Imperfectly exposed, 750' hor. dist., | 650' |
| Below the middle of this interval, a double sandstone, gray, coarse-grained, is shown on the hillside north from the railroad grade. Some of it is decidedly conglomerate. The hillsides are badly slipped on both sides of the valley and no good exposure was found; but here and there a partial exposure shows that the greater part of the interval is occupied by shales, so that this bed probably represents the <i>Lower Conglomerate</i> . | |
| 15. Concretionary shale, 80' hor. exp., | 26' |
| 16. Concealed, 120' hor. dist., | 104' |
| 17. Shale, dip. 63 deg., 195' hor. exp., | 173' |
| This shale is sandy, brown to olive, with some irregularly bedded sandstones, clayey and reddish brown. Some of the layers are very ferruginous. This exposure begins above the culvert on the railway grade and it was made by cutting. | |
| 18. Concealed, 285' hor. dis., | 238' |
| 19. Shales and flags, dip 58 deg., 150' hor. exp., | 128 |
| Shales olive, the flags fine-grained, reddish brown to bluish gray. Midway is a layer with <i>Spirifera disjuncta</i> , higher up is another fossiliferous bed filled with <i>Aviculopecten</i> , while near the top is a thin coarse ferruginous limestone containing <i>Spirifera disjuncta</i> , crinoids, and other forms not distinguishable. Toward the base, | |

the whole becomes dark brown and passes gradually into

20. Shales, 180' hor. exp., 156
Irregularly bedded, slickensided, dark brown to reddish.
Pass gradually into
21. Shales with flags, 60' hor. exp., 52'
22. Shale and sandstone, 62 deg., 165' hor. exp., 145'
Sandstone blue and flaggy in flags 1 to 3" thick.
23. Sandstone, 63 deg., 180' hor. exp., 160'
Blue, fine-grained, irregular fracture, contains *Spirifera disjuncta* at 90 feet from bottom.
24. Shales, 150' hor. exp., 135'
Dull brown and irregularly bedded at top but become regularly bedded lower down. Shown at upper end of long railroad cut opposite Eichelbergertown; also on country road near the School-house, where they contain flags 1" to 2" thick.
25. Concealed, 650' hor. dist., 552'
26. Shales and flags dip, 55 deg., 40' hor. exp., 32'
Shown in railway cut at W. H. H. Eichelberger's house, where the railway leaves the creek and follows a small tributary. The shales are olive to brown with flags 3" to 20" thick; the flags are well shown in the hillside above this house, but the shales are exposed only in the out. Possibly these beds should be included in the Hamilton.

Hamilton.

27. Not well exposed, 275' hor. dist., 225'
This was measured along the country road leading westward from Eichelbergertown. It contains much shale dark to dull brown; some laminated grayish sandstone occurs in this interval.
28. Sandstone, 110' hor. exp., 95'
Contains some drab shale, but mostly laminated sandstone with *Spirophyton* and some obscure molluscan forms.
29. Shales, 128' hor. exp., 86'
Brown to grayish-brown and sandy.
30. Sandstone, 45 deg., 101' hor. exp., 70'
Laminated, gray, fossiliferous, contains *Spirifera mucronata*, *Chonetes*, 2 sp., *Lucina lirata*, *Modiomorpha concentrica*, crinoid stems.
31. Concealed, 176' hor. dist., 120'
32. Brown shale, 31' hor. exp., 20'
33. Sandstone, 51' hor. exp., 35'
34. Concealed, 150' hor. dist., 105'
35. Ill-exposed, estimated at 1500' hor. dist., 1000'
At the top of this interval one comes to the variegated shales, but the exposures soon become indifferent and the irregularity of the lane renders pacing uncertain. Fragments of blue limestone were seen toward the base amid poorly exposed very black shale.

Oriskany.

36. Sandstone of the Oriskany, forming the top and eastern slope of Warrior ridge. It is shown very poorly.

The road leading northward from Tatesville to Yellow creek follows the eastern foot of Warrior ridge, sometimes lying on the Marcellus shale and sometimes encroaching somewhat on the Oriskany sandstone of the ridge. At Yellow creek, the road passes behind the ridge but crosses again to the east side at Weimer's gap near the northern edge of this township and immediately passes into

Liberty township.

The Lower Helderberg is partially exposed in Weimer's gap where it dips eastwardly at 65 degrees; the Oriskany is shown in the same gap opposite Mr. Weimer's house and the Marcellus shales are reached at the mouth of the gap.

The Liberty township line is barely 100 rods north from the gap. There the Oriskany sandstone is not more than 5 rods west from the road, while the Marcellus shales with blue limestone are frequently well shown at the roadside. Warrior ridge soon becomes irregular and, for considerable distances on each side of the gaps, it almost disappears. At Bollinger's gap and thence to J. B. Zook's house, the shales are nearly vertical and at a little way further north they are dipping eastward at 80 degrees. Here they are very black. The same black shales have been thrown out near the Raver's Run School-house. They are shown in contact with the Oriskany at W. Shimer's place just beyond Raver's run and a bed of the limestone crops out in his orchard. Some shelly *brown hematite* lies in small fragments on the surface here, but the quantity appears to be insignificant.

Warrior ridge is so destroyed by erosion for nearly two miles north from Raver's run, that its place can be ascertained only by the loose fragments of Oriskany sandstone strewn over the surface. It is at only a few rods west from the road. But it becomes distinct beyond the first fork of the road and can be followed thence to the county line as a low rolling ridge.

Turning westward at the first fork and taking the road leading to Saxton, one is in the Hamilton until near the main road. Thence to Saxton, rocks belonging to the Chemung series alone are exposed. The sandstones of the group are well shown at the river ford, where they dip eastwardly at nearly 50 degrees.

The cuts along the old grade of the Huntingdon and Broad Top railroad at Saxton afford good exposures of the Chemung above the *conglomerate*, while the long cuts on both the old and the new grade of the same road north from the river exhibit the lower beds. Beginning at about 30 feet beyond the present termination of the track on the old grade in Saxton, the following succession was made out, the thicknesses being estimated :

1. Imperfectly exposed, 60
Contains much red shale with thin beds of muddy sandstone, not regularly bedded, and holding *Spirifera disjuncta* and *Orthis*. Dip 55 deg. S. 55° E.
2. Sandstone, 15'
Argillaceous, irregularly bedded, brownish yellow on exposed surface, but brownish red on fresh surface.
3. Shales, 65'
Variegated; brownish red, 20'; yellow, 10'; bright red, 12'; and yellow, 23'.
4. Not fully exposed, 60'
Contains some light gray hard sandstone, with *Orthis tioga*, *Spirifera disjuncta*, *Streptorhynchus chemungensis*; has some thin slabs of red clayey sandstone with mud-flow markings.
5. Sandstone, 5'
Flaggy to laminated, brown or reddish brown; bears much resemblance to the Catskill sandstones.
6. Concealed. 115'
This interval shows no rocks in place, but the surface is thickly strewn with fragments of a red, thinly laminated sandstone, such as No. 5.
7. Shale, 8
Red, fissile, contains slabs of muddy sandstone with *Spirifera disjuncta*.
8. Sandstone, 0' 8"
This is probably only a sandy shale. It is richly fossiliferous, but in the decomposed outcrop the forms are too badly weathered to be recognized.
9. Shale, 90'
Variegated, red to yellow, with slabs of micaceous clayey sandstone, 1' to 8' thick. Near the base its dip is 65 deg. eastward.

10. *Conglomerate*, 10'
 Bluish gray, very hard, pebbles of white quartz, rounded, some of them flattened, varying in size from pea to pigeon's egg. Jointed, with films of quartz along joint-planes. Some layers of fossiliferous, but the forms are too indistinct for identification.
12. *Shale*, 30'
 Mostly dull yellowish, but some parts dark brown.
13. *Sandstone*, 12'
 Upper part brown, slightly calcareous, streaked with quartz; lower part conglomerate, grit-like; fossils present but very indistinct. Dip is 55 degrees.
14. *Red shale*, 5'
15. *Sandstone and shale*, 50'
 This interval brings one to the side of the river at the railroad bridge. The Conglomerate, 10, and the sandstone, 13, form a distinct ridge on the south side of the river, but this ridge is wanting near the river on the north side, though it re-appears within half a mile. The concealed interval could not be determined accurately. It is estimated.
16. *Concealed*, 600', hor. dist., 450'
 The distance cannot well be determined by pacing as much of it lies in the river bed.
17. *Shales*, dip 46 deg., 140', hor. exp., 101'
 Variegated, mostly fissile, with sandstone flags 3" to 10" thick, the latter very hard and fine-grained.
18. *Sandstone* dip 36 deg., 7'
 Fine-grained, hard, gray to bluish gray; quartz on the planes of jointing.
19. *Shale*, olive to drab, 8'
20. *Sandstone* like No. 18, 2'
21. *Shale*, 5'
22. *Sandstone*, 4'
23. *Shale with sandstone flags*, 20'
24. *Sandstone*, 30'
 Dip flexuous, 35 to 80 degrees; sandstone hard, fine-grained, bluish; some thin beds of shale.
25. *Shales*, sandy, with sandstone flags, 30'
26. *Sandstone*, 16'
 These rocks from No. 22 to No. 26 inclusive form a bold ridge. The sandstones are shown distinctly in the river wall and can be recognized readily even from the opposite bank of the stream. The measurements were made by following the road along the north bank below the railroad bridge. Within half a mile north from the river, the ridge made by these sandstones is separated from that of the *Conglomerate* by a narrow saddle.
27. *Ill-exposed*, 285', Hor. dist., 185'
 This interval contains much shale, which is more or

- less fissile, but details cannot be obtained from the imperfect exposures.
28. Sandstone, dip 45 deg., 35'
Gray to bluish gray and hard.
29. Shales, dip 38 deg., 150', hor. exp., 93'
These are not well shown along the road but they are fairly well exhibited further up the hill near the old railroad grade, where they are seen to be yellow, and in great part fissile. At a little below the middle they hold the *Lower Conglomerate*, which is 8 feet thick and bears much resemblance to the No. 10 of this section. Flags of sandstone occur below the Conglomerate. No fossils were seen. The dip is 38 degrees.
30. Shales and flaggy sandstone, dip 38 deg., 70'
Shown on the river road above and below the railroad, but best exposed in a long cut on the old grade. There is much olive shale and clayey micaceous sandstone. A fossiliferous layer was seen near the west end of the cut which contains crinoid stems, *Rhynchonella contracta*, *Productella* and *Streptorhynchus*.
31. Concealed interval, 500', hor. dist., 310'
This is largely estimated. A few partial exposures along the creek show flaggy sandstone but afford no details.
32. Sandstone, 10'
Shown at mouth of next cut on the old grade and on siding leading to Powelton furnace.
33. Variegated shale in cut, 36 degrees, 40' hor. exp., 24'
34. Shales and flags, 50 degrees, 515' hor. exp., 396'
For the most part olive; shales alone in the middle and at base, but elsewhere flags predominate. Well shown in cut to end and beyond that for 40 feet on the country road.
35. Concealed, 60' hor. dist., 42'
36. Shale, 40' hor. exp., 28'
Seen in country road near Eyster's house. It is argillaceous. Crossing the run here and taking the railroad grade one comes to
- 37 Sandstone, 40 degrees, 330' hor., exp., 211'
The upper part is shown on opposite side near Eyster's house, the whole well exposed in long side-cut on railroad grade. Brown or very dark gray, fine-grained, flaggy, very little shale. No fossils seen.
38. Shale, 330' hor. exp., 230'
The last passes very gradually into this. Color olive to drab. Some flaggy sandstone. The mass becomes more sandy below; within 35' hor. of bottom it contains irregular, slightly calcareous layers with *Spirifer disjuncta*, *Leiorhynchus quadricostatus* and crinoid stems. At the bottom it has 4" to 6" of ferruginous grit.
39. Shale, 160' hor. exp., 120'

The passage from the last is almost imperceptible, but these are more or less fissile; some parts are ferruginous, and some calcareo-ferruginous beds were seen near the bottom.

40. Concealed, 30'
41. Shales, dip 55 degrees, 275' hor. exp., 225'
More or less fissile, weathering yellow; some sandstone flags with *Rhynchonella* and a *Spirifera* near to *S. mesastrialis*, but too indistinct for determination.
42. Shale, 170' hor. exp., 132'
Not fully exposed; upper part dark brown.
43. Shale, 400 feet hor. exp., 310'
Fissile variegated, brown, gray, olive, and yellow; seems to be a continuation of the last and is well exposed.
44. Concealed, 160' hor. di-t., 116'
45. Shale, dip 45 degrees, 235' hor. exp., 165'
Very similar to that in No. 34 but is not fissile. It holds irregular flaggy sandstone. Only 175' of this is shown on the railroad, the rest having been obtained from an exposure on the country road following the opposite side of the valley. No further exposures occur on the railroad, which soon leaves the stream and goes northward.
46. Shales and flags, 48 degrees, 275' hor. exp., 203'
Mostly olive, shown on country road and extends to railroad crossing just below the forks of the run.
47. Concealed, 320' hor. dist., 237'
This is in the stream bottom. In this interval the base of the Chemung series is reached and part of the Hamilton also is included, for in passing beyond the stream-bottom one comes to

Hamilton.

48. Shales, 80' hor. exp., 59'
Which belong to the middle division of the Hamilton. These are fissile, dark brown, fossiliferous and contain *Tropidoleptus carinatus*, a large *Chonetes*, *Bellerophon patulus*, *Bellerophon* sp. and *Pleurotomaria*.
49. Sandstone, 48 deg., 60' hor. exp., 44'
Laminated dark gray, contains *Spirophyton*.
50. Shale, 52 deg., 170' hor. exp., 134'
Brown to yellow, bedded.
51. Sandstone, 90' hor. exp., 71'
Laminated, dark gray, contains *Spirophyton*, *Tropidoleptus*, *Spirifera*, and crinoid stems.
52. Ill-exposed, some shale, 110' hor. exp., 87'
53. Sandstone like No. 51, 10' hor., 8'
54. Concealed, 80' hor. exp., 63'
55. Shale dark, fissile, 65' hor., 47'
56. Ill-exposed, much shale, 80' hor. exp., 57'
57. Dark shale, 45 deg., 60' hor. exp., 42'

58. Sandstone, 87' hor. exp.,	58'
Laminated dark gray, with <i>Spirifera</i> , <i>Tropidoleptus</i> , <i>Streptorhynchus</i> , <i>Leiorhynchus</i> , and crinoids.	
59. Shales, sandy, 90' hor. exp.,	63'
60. Concealed, 85' hor.,	60'
61. Shales, 300' hor. exp.,	231'
Drab to gray, weathering dirty white.	
62. Concealed, 134' hor. dist.,	103'
63. Shales, 50 deg., 400' hor. exp.,	308'
Fissile, dark to black.	
64. Shale and limestone,	68' 5'
65. Concealed, 110' hor. dist.,	84'
66. Oriskany sandstone not well exposed.	

The interval No. 64, is well shown in detail at the bend in the road opposite the Reformed church. The measurement is as follows :

1. Shale, black, wrinkled like gneiss, breaks like rotten wood,	12' 0"
2. Limestone, blue, non-fossiliferous,	0' 5"
3. Shale like No. 1,	0' 2"
4. Limestone,	0' 3"
5. Shale,	0' 6"
6. Limestone,	0' 2"
7. Shale,	1' 0"
8. Limestone,	0' 2"
9. Shale, wrinkled,	3' 0"
10. Limestone,	0' 3"
11. Shale, wrinkled,	1' 0"
12. Limestone, upper surface wrinkled,	0' 3"
13. Shale,	5' 0"
14. Limestone,	0' 5"
15. Shale,	4' 0"
16. Limestone,	0' 4"
17. Shale,	12' 0"
18. Limestone,	0' 6"
19. Shale,	1' 3"
20. Limestone,	1' 0"
21. Shale,	10' 0"
22. Limestone,	0' 5'
23. Shale,	7' 0"
24. Limestone,	0' 4"
25. Shale,	8' 0"

Unfortunately, much of the Chemung section cannot be regarded as exact, since the measurements were made in a direction somewhat off the dip. This defect exists in that part extending from No. 32 to No. 47 inclusive. Due allowance being made, these measurements would be reduced nearly

one half. The upper part of the Chemung and that of the Hamilton are approximately correct as given; so that the thickness of the Chemung series is approximately 2,900 feet, and that of the Hamilton approximately 1,700 feet.

Near the Reformed church, the road crosses Warrior ridge, and thence northward to the Cypher School-house lies on the west side of the ridge; but at the school-house it rises upon the ridge and thence to the county line lies either on the black Marcellus shales or on the Oriskany sandstone. Frequent exposures along the road indicate that the shale and limestone series is continuous quite to the sandstone and that the concealed interval, No. 65 of the section, shows alternations of shale and limestone similar to those seen in No. 64. The shales are as black in the lower as in the upper part of the mass. The Oriskany is soft and for the most part yields readily to erosion.

Returning now to Saxton and taking the Stonerstown road one finds, beginning at the west, the *Chemung upper conglomerate* at the first house west from the railroad. Following the road east to the railroad, no exposures are found until within about 200 feet of the railroad; but when exposures begin near the railroad they are those of the red Catskill shales and sandstones. In the railroad cut these are blood red mud rocks dipping S. 70° E. at 48 degrees. Many of the layers are covered with ripple markings.

After passing this cut, no further exposures were found along the railroad until the river bend was reached, where a long side-cutting shows deep red shales with beds of greyish and brown micaceous sandstone, 3 to 20 feet thick and much cross-bedded. The dip varies from 30 to 55 degrees. The map is seriously in error here and the river should be carried further east so as to touch Allequippa mountain, for the Pocono is at only a little way east from the head of this bend. But to correct this error would involve reconstruction of the whole north-east corner of the map; so that in laying down the geology here, the course of the stream and that of the railroad have been ignored, and the boundaries of the groups have been indicated with reference to locali-

ties further south, whose place is given with some approach to accuracy.

A long concealed interval follows the last exposure, but exposures begin again at the watch-house, where deep red shales are shown, overlaid by grey irregularly bedded sandstone of the Pocono, the latter at least 50 feet thick. The shales are dipping 30 degrees and the sandstone 50 to 60 degrees eastward. With this the exposure ends and the road turning westward again reaches the shales, so that at J. Clarke's house it enters a deep cut in which the shales are dipping eastward at 40 degrees. They contain some irregularly bedded sandstones.

At the mouth of this cut the road bends more sharply eastward and one comes almost at once to the Pocono sandstone seen in the watch-house cut further down the railroad. Here the river breaks through Allequippa mountain and the following section of the Pocono is exposed:

Pocono.

1. Sandstone, 58 deg., 730' hor. exp., 620'
Grey to light grey; many layers pebbly and irregularly bedded; very little shale; at 320' from bottom, 2 inches of *carbonaceous* shale were seen with much carbonized wood in adjoining layers. Near the top the rock is flaggy and shows many lumps of *iron ore*. The dip varies from 45 to 58 degrees, the latter near the top.
2. Shale, 45 deg., 100' hor. exp., 70'
3. Sandstone dip 28 ? deg., 75' hor. exp., 45'
Grey, irregularly bedded and jointed. Dip uncertain.
4. Shale, 400' hor. exp., 248'
Like No. 2, red, with some irregularly bedded sandstone.
5. Sandstone, 38 deg., 200' hor. exp., 125'
More or less flaggy, irregularly bedded, grey to brownish grey; contains layers of conglomerate, 8" to 2' thick, made up of balls of red shale and nodules of *brown hematite* in fine sand.
6. Sandstone and shale, 40 deg., 400' hor. exp., 257'
Shown above mouth of cut in alternating beds of sandstone and shale, of nearly equal thickness.

The exposure is complete, except in the lowest division, which, however, is fairly well shown in a natural exposure below the track. The rest has been exposed by side cuttings. Before reaching the top of the section the road has passed into

Broad Top township.

A concealed space of 40 feet horizontal extent lies between the top of the Pocono and the lowest exposure of the Mauch Chunk. Thence to the westward curve at the river above Riddlesburg the exposures of shales are almost continuous. Beginning at this first exposure and ascending the river one finds at the base of the group some red calcareous shales, with blood red shales, the latter showing no bedding. Blotches of crystalline limestone are shown on the surface of the clays. In ascending, this rock becomes bedded and passes into a laminated clayey sandstone, which higher up becomes thick-bedded. The dip is S. 60° E. at 52 degrees. This exposure continues for 400 feet and ends with a vertical exposure of 60 feet, giving in all a vertical thickness of not far from 375 feet. Here the road turns westward and for a little follows the strike; but soon bending eastward, it comes again to the highest beds of the last exposure and the section continues beyond the deep cut, where the dip is 46 degrees and the exposure about 200 feet long, giving a vertical thickness of 140 feet additional. The rocks are regularly bedded here and the compact layers are from 2'' to 12'' thick. These are hard red sandstone.

The road bends again and its course is but little off the strike. The additional exposure continues for 1,050 feet with a dip in of not more than 10 degrees in the direction of the road. At the end of this interval an anticlinal, probably the Clear ridge, is indicated. Here the road makes a long bend westward, which continues to Riddlesburg, so that the Pocono sandstone is in the river bed, while a long nose of Mauch Chunk extends westward from the Pottsville-capped ridge, which forms the western boundary of the Broad Top Coal Field. The dip of the Mauch Chunk at the mouth of Six-Mile run below Riddlesburg is 56 degrees. This is very near the bottom of the Mauch Chunk and the Pocono is shown in the river bed opposite this place. In sinking for the piers of the bridge over the river at Riddlesburg, it was necessary to make a considerable excavation in the Pocono on the Hopewell side. Mr. Lauder, of the Kemble Coal and Iron Company, informs me that three

coal beds were found within a vertical distance of 10 feet and that the beds varied little from two inches each. Mr. W. Kelly, superintendent of the Kemble Company's furnaces at Riddlesburg, gives the following analysis of the red limestone occurring near the base of the Mauch Chunk :

Mauch Chunk limestone.

Carbonate of lime,	69.55
Insoluble matter,	23.00
Metallic iron,	5.00

Showing that while the limestone is useless for any manufacturing purposes it is not worthless to the farmer.

The exposure of Mauch Chunk on Six-Mile run is not wholly continuous but is a good natural exposure. A succession of red shales and red to brownish red sandstones continues for a horizontal distance of 1,830 feet, with the dip diminishing eastward from 56 to 45 degrees; but from this horizontal distance fully 400 feet should be deducted on account of two anticlinals, which are shown in part along the river below Riddlesburg, but better above Riddlesburg toward Hopewell; so that the vertical thickness appears to be not far from 1,050 feet. The Pottsville conglomerate is reached at a short distance below Mr. John Mitchell's house and continues for a horizontal distance of 540 feet. The exposure is very poor and the bottom of the rock cannot be recognized now; but the full extent of the group was determined some years ago by a succession of openings along the front foot of the hill. The dip at the several exposures varies from 45 to 25 degrees, the rate decreasing eastward. The thickness is probably not far from 250 feet.

The *Lower Coal Measures* have been exposed by the Kemble Coal and Iron Company, so that the section between the conglomerate and the large bed mined by that company can be made out without difficulty. The following is the succession on the north side of the run :

1. Sandstone,	Not measured.
2. Shale,	10'
3. <i>Coal bed, Speer (?)</i> ,	3' 6"
4. Interval with sandstone and shale,	20'
5. <i>Coal bed, Kelly</i> ,	7'

6. Interval vertical at 18 deg., 124' 6",	118' 2"
7. <i>Coal bed, Twin</i> ,	1' 5"
8. Sandstone, dip 24 deg., 40' hor. exp.,	16'
9. Shale,	3'
10. <i>Coal bed, Barnet</i> ,	5'
11. Not fully exposed, mostly shale, 50' hor. dist.,	35'
12. <i>Coal bed, Cook</i> ,	2'
13. Shales and sandstone, belonging to Pottsville conglomerate, not fully exposed.	

The details of the shales and fire-clay beds are not shown.

A continuous exposure on the opposite side of the run shows a very different succession in the lower part of the section, thus :

1. <i>Coal bed, Twin</i> ,	1' 5"
2. Sandstone, very hard, dip 47 deg.,	4' 6"
3. Shale,	2' 6"
4. <i>Coal bed, Barnet</i> ,	2'
5. Sandy shale, 50' hor. exp.,	38'
6. <i>Coal bed, Cook</i> ,	2' 6"
7. Twisted sandstone and shale, 53 deg., 30' hor. exp.,	24'
8. <i>Coal bed</i> ,	0' 8"
9. Mass of Pottsville conglomerate.	

Nos. 7, 8 and 9 belong to the Pottsville, and the little *coal bed* varies in thickness from 2 to 8 inches. The *Kelly coal seam* has been mined on the hill south from the creek, but the interval to the *Twin* was not determined. The interval between the *Kelly* and *Twin seams* as given in the first section is taken from the record of a boring made by the Kemble Coal and Iron Company near the railroad track. In detail it is as follows :

1. Interval from <i>Kelly</i> seam to curb of boring,	32'
2. Débris,	15'
3. Sandstone,	1' 1"
4. Shale,	23' 6"
5. Sandstone,	9'
6. Shale,	9'
7. Sandstone,	3' 4"
8. Shale,	10'
9. Sandstone,	21' 2"
10. Shale,	0' 5"
11. <i>Coal bed, Twin</i> ,	1' 8"
12. Shale,	0' 6"
13. Fire-clay,	0' 6"
14. Shale,	14'
15. Sandstone,	3'
16. Shale,	1' 2"
17. Sandstone,	0' 4"

18. Shale,	20' 4"
19. <i>Coal seam, Barnet,</i>	1' 4"
20. Fire-clay,	9'
21. Shale,	2' 6"
22. Sandstone,	0' 5"
23. Shale,	12' 5"
Total depth of boring,	<u>178' 7"</u>

The vertical distance between the *Twin* and *Barnet coal beds* is 37 feet.

The bottom of this first basin is reached just above where the road leading to the Mt. Equity coal mine leaves the run. Thence the rocks rise to the first axis of the Broad Top coal field.

The highest bed of the section, the *Speer*(?), is exposed above the Mt. Equity mine on a by-road, where it has been prospected for the Kemble Company by their mine-boss, Mr. Mitchell. The opening is closed by a fall, but the structure of the bed as given by Mr. Mitchell is:

Coal,	2' 6'
Clay and shale,	0' 6"
Coal,	0' 6"

Fragments of the *coal* still remain near the mouth of the pit and show it to be good but hard. Mr. Mitchell maintains that the coal is excellent and that the only drawback is its hardness, which makes mining expensive in a thin bed.

The *Kelly coal seam* is mined at the Mt. Equity mine by the Kemble Company, at half a mile from Riddlesburg. The section of the bed as shown in this mine is

1. Coal, upper bench, 2' 1"
2. Parting.
3. Coal, bearing-in, 0' 7"
4. Parting.
5. Coal, middle bench, 1' 2"
6. Parting.
7. Coal, lower bench, 1' 2" to 10"
8. Clay, 2'
9. Coal, 0' 4"

The upper bench is good clean coal throughout at most places examined, but at a few spots a streak of bone occurs, which seldom exceeds 4 inches and for the most part is

very thin, often wholly absent. The bearing-in bench shows no parting and carries gray coal. The middle bench is like the upper, but the lower bench differs from the others both in structure and composition. Its coal is distinctly laminated and the laminæ are continuous for long distances; while the coal of the other benches is more or less twisted and is invariably slipped. Much pyrites is present in this lower bench and binders of slate are numerous. The clay, No. 8, is black, more or less shaly and contains impressions of stems. No. 9 is worthless bone. Only the higher benches are mined, and the coal from these is coked for use at the furnaces of the Kemble Company.

The roof in this mine is secure but is irregular and its "rolls" are sufficiently extensive in places to cut out nearly all of the coal. They invariably injure the coal for several yards on each side, though the extent of injury varies greatly. One great roll has pressed out all of the coal so that the accumulation on one side, as reported by Mr. Mitchell, is nearly 16 feet thick. The coal in this pocket is slipped and polished so as to be unmarketable. Some of the rolls extend very far; one of them, 6 to 8 yards wide, is certainly several hundreds of yards long, but it shows gaps here and there by which it may be crossed without difficulty and at slight expense. The mining is somewhat complicated. The opening is on the west side of the anticlinal and the main gangway follows the strike as nearly as may be for between 200 and 300 yards, but there its course is changed owing to the presence of a distinct fold. This fold continues northward for a long distance and appears to be secondary to the main axis lying further east. A section of the workable part of the bed, analyzed by Mr. A. S. McCreath, shows the following composition:

Water,	0.435
Volatile matter,	19.245
Fixed carbon,	73.865
Sulphur,	1.039
Ash,	5.416
Color of ash,	gray.

A sample of the coke was sent, which, according to Mr. McCreath, has the following composition:

Water,	0.095
Volatile matter,	0.575
Fixed carbon,	89.083
Sulphur,	0.925
Ash,	9.322

Showing a coke of decidedly excellent quality, though owing to the small proportion of volatile matter in the coal it might not be able to bear the burden of a high stack. But it answers admirably in the company's furnaces at Riddlesburg.

Some old openings in the *Kelly coal seam* were seen just west from the Mt. Equity mine, but they have been deserted owing to troubles in the mine, some of which were very complicated. The same bed was mined on the south side of Six-Mile run, but in that part of the basin lying west from the subordinate anticlinal observed in the Mt. Equity mine. Owing to the increasing strength of that anticlinal southward and to the consequent shallowing of the basin, the *Kelly coal* comes out to daylight far up on the ridge at barely half a mile from the run. The coal from this mine was very good but it has been worked out.

The *Twin seam* is unimportant. It is not a double bed and no distinct or persistent partings were seen at any of the exposures in this basin. The coal is fairly good but is too thin to be worked.

The interval between the *Kelly* and the *Twin* is not exposed along the run, but its general character is shown by the record of the Kemble Company's boring. A material change must occur in the upper part at a short distance south from the run, for where the workings in the *Kelly seam* come to the air, the trough of the coal is marked distinctly by a very coarse sandstone, parts of which are conglomerate and which, as a whole, bears a decided resemblance to the sandstone overlying the *Speer? coal bed*. This rock is shown in a cliff, but the exposures do not suffice for determination of its thickness. Below the *Twin*, however, the exposure on the north side of the run is complete, showing that the interval to the *Barnet* is occupied almost wholly by sandstone. The variation of this interval within 100 rods is curious and well-marked. It seems to be alto-

gether local, for at other places the beds are at approximately the same distance apart. There is besides a difference in dip on the sides of the narrow valley through which the run flows.

The *Barnet coal bed* is not mined in this basin as the *Kelly coal bed* is thicker and gives rather better coal. At an old exposure, now closed, the structure of the bed, according to Mr. Mitchell, is

Bony coal,	0' 10"
Coal,	2' 10"
Slate,	0' 4"
Coal,	1' 2"

The opening is directly above Mr. Mitchell's house, but the coal is inferior to that from the *Kelly seam* in the Mt. Equity mine. On the opposite side of the valley, the bed varies in thickness from 1' 5" to 2' and the coal is somewhat inferior in quality.

The interval to the *Cook seam* is fairly well shown on both sides of the valley and is filled with sandy shale. The *Cook seam* is not mined. It was opened at one time near Mr. Mitchell's house and it is well exposed on the opposite side of the run. Its thickness varies from 2' to 2' 6" and the coal is not good.

The *coal bed* of the Pottsville is not shown on the north side of the run, but is fairly well shown on the south side, where it is much squeezed and the coal is without value. As already stated, the Pottsville is ill-exposed, the upper part alone being shown. So far as seen, the rock is not a very coarse-grained sandstone, but fragments belonging near the bottom indicate the presence there of a coarse conglomerate.

The first anticlinal of the Broad Top coal field is crossed by the railroad at, say, 200 yards above the Mt. Equity dump. North from the run, this axis makes a bold ridge known as Mt. Equity, but southward it is deeply trenched by a tributary stream; in this southern prolongation, the coals are carried high up on the hill sides by the increasing strength of the axis in that direction and, without doubt, the Pottsville is well brought up at an inconsiderable dis-

tance south from the railroad. In the Mt. Equity mine on the west side of the axis, the coal rises eastward to the crest where the dip becomes insignificant. It is gentle beyond the crest for a considerable distance. The upper sandstone of the first section given forms the eastern slope of the ridge north from the run and it is fairly well exposed for some distance. Its dip varies little from 45 degrees and the thickness of the rock was estimated at 60'. Shales overlie it, but exposures are very bad. Shales with approximately the same dip were seen at the foot of the hill where one is fairly in the second basin. Here at the time of examination, Mr. S. T. Brown of Huntingdon was drilling in search of the *Kelly coal bed*. The record of the boring as far as it had gone is as follows:

1. Open shaft,	25'
2. Shale,	5'
3. Sandstone,	10'
4. Shale,	3' 8"
5. Sandstone,	21' 10"
6. Shale,	2' 2"
7. Sandstone,	0' 4"
8. Shale,	6' 4"
9. Sandstone,	2' 10"
10. Shale,	0' 10"
11. Sandstone,	1' 6"
12. Shale,	6' 4"
13. Sandstone,	23' 11"
14. Shale,	2' 9"
15. Sandstone,	12' 2"

Some *coal* was found in the open shaft at about 12 feet from the surface. If the dip be 45 degrees at the place of boring, a very deep shaft will be necessary in order to reach the *Kelly seam*.

Following the railroad, one finds no satisfactory exposure of the great sandstone, though it can be reached by leaving the railroad and following the foot of the mountain for a few rods. An imperfect exposure occurs at the first cut above the Mt. Equity mine, but it is short and unsatisfactory, and the next exposure is beyond the bridge where the railroad and the county road touch. The section, beginning just above this, is

1. Shale,	30'
2. Coal bed,	2'
3. Shale and flaggy sandstone,	30'
4. Sandstone,	16'
5. Concealed, hor. dist. of 350'.	
6. Gray moderately coarse sandstone,	60'

No. 6 is the sandstone overlying the *Speer ? coal seam*. Its dip is 45 degrees. The concealed interval is in the immediate valley of the run and is estimated at 350 feet, though accurate measurement may show it to be somewhat greater. The sandstone, evidently the same with No. 5 of Mr. Brown's boring, is exposed at the point of the road, where it dips eastward at 20 degrees. In the concealed interval, the rate of dip has diminished from 45 to 20 degrees. At present one cannot determine satisfactorily the rate of diminution and consequently the distance of the *Kelly coal seam* beneath the surface can be ascertained only by boring. The *coal bed*, No. 2, is evidently that of which the smut was found in Mr. Brown's boring. Mr. Mitchell says at one time it was digged in the bed of the run, whence good coal was obtained. At present the only exhibition is a smut at the roadside, which indicates that the bed is double with the upper bench thicker than the lower. The thickness is not far from two feet. Here the dip is very gentle and, within a few yards, the bottom of the first sub-basin is reached. The dip does not exceed 5 degrees. A *coal bed* is reported to be present at 400 feet above the bed, No. 2 of the last section. The distance has been leveled. The thickness is given as 4 feet. As no exposure of the bed remains, its character and relations must remain uncertain.

No coal openings were seen in this second basin, as the *Kelly seam* is deeply buried, but that quickly comes up on the west side. A sandstone occurs near the old School-house, dipping westward at 14 degrees, under which the *Kelly coal* should be found. A thin *coal bed* was once prospected near the western edge of this second basin, but its place is concealed now and its relations could not be ascertained.

The second anticlinal of this field is reached very near the new School-house, for the easterly dip is shown at a few

rods above that building and the westerly dip at a few rods below it. The dip on the west side is comparatively gentle, while that on the east side is abrupt. The axis passes between the openings made by Reed Wilson & Co. in the *Kelly coal seam* on the ravine entering from the north below the Duval shaft. These openings have been abandoned as the available coal above drainage proved to be insignificant and was soon worked out.

The Duval shaft is but a few yards east from the axis of the third basin. From the landing to the *Kelly coal bed* is 100 feet. No details were obtained respecting the section found in the shaft; the coal resembles that mined in the Duval entries further east. The shaft is no longer worked. Most of the available coal has been removed; and not a little difficulty was encountered latterly in mining along the western side owing to the very rapid rise of the coal in that direction.

The third anticlinal passes between the two Duval entries, which are immediately below the village of Fairplay or Coaldale. The course of the axis is N. 32° E. The mines are operated by E. P. Jenkins and the entries meet at the crest of the axis. The dip in the lower entry is 28 degrees westward, while that in the upper one is 38 degrees eastward. A massive sandstone begins at a few feet above the coal and continues to 80 feet above it in the hill, showing a thickness of about 60 feet. At the upper opening, sandstone begins directly above the coal bed, which there has the following structure:

Kelly coal bed.

Coal, upper bench,	2' 5"
Parting,	0' 3" to 0"
Coal, lower bench,	1' 7"
Clay,	1' 3"
Coal,	0' $\frac{1}{2}$ "
Clay,	0' 10"
Coal,	0' $\frac{1}{2}$ " to $\frac{1}{8}$ "

This pit is immediately below the Coaldale church. The middle and bearing-in benches are wanting and the only coal, not very inferior, comes from the upper bench; while

even that is decidedly inferior to coal from the same bed at the Mt. Equity mine. Thin partings break up the coal here and many of these contain pyrites. The lower bench shows the same features as in the Mt. Equity mine.

The next basin, the fourth, is very shallow and its axis passes through Fairplay. The *Kelly coal bed* is not carried under, but lies at a considerable distance above the country road. The anticlinal bounding it at the east, the Cunard axis, is gentle here and just perceptible in the bank of the run at a little way below the Cunard shaft. The *Kelly* and *Twin* seams are shown in the bluff and the *Barnet seam* is in the bed of the run. The *Kelly coal bed* was mined at one time on the north side of the run by Reed Wilson & Company, but the coal proved to be very inferior and the mine was abandoned.

Passing this anticlinal, one comes to the narrow basin in which the Cunard shaft is situated. The following measurements were made here:

1. Wholly concealed,	100'
2. <i>Speer coal seam</i> ,	4'
3. Interval,	?
4. <i>Kelly coal seam</i> ,	4'
5. Interval,	76'
6. <i>Twin coal seam</i> ,	1' 6"
7. Interval,	30'
8. <i>Barnet coal seam</i> ,	4' 11"
9. Interval,	10' to 8'
10. <i>Cook coal seam</i> ,	3' 6"

The dip is from 11 to 14 degrees westward.

The upper bed, known as the *Speer bed*, is no longer exposed. Mr. Wigton opened it at two places and he gives the structure as follows:

Coal,	1'
Shale,	2
Coal,	1'

The parting is occasionally sandstone. The coal is moderately good but is unavailable. The interval to the *Kelly coal bed* was not made out satisfactorily. The vertical distance between the two openings is 50 feet, as leveled, but a considerable horizontal interval lies between them, in which

the dip is important. The true vertical interval is probably not more than 30 feet.

The *Kelly seam* was opened by Mr. Wigton and mined for some time. A large quantity of coal was taken out. The structure of the bed is :

Coal,	2' 1"
Clay,	0' 7" to 0'
Coal,	1' 0'

The upper and lower benches alone are present, the bearing-in and middle benches being absent. The lower bench shows the same features as at the Mt. Equity mine, is laminated, full of clay binders with occasional balls of pyrites and much pyrites in the binders. The upper bench occasionally shows nodules of pyrites and has much of that mineral scattered in minute crystals through the clay binders. The quality of the coal is so inferior that it cannot be marketed and so the mine was abandoned. A sample of the coal analyzed by A. S. McCreath shows the composition to be as follows :

Water,	0.610
Volatile combustible matter,	20.375
Fixed carbon,	67.497
Sulphur,	3.583
Ash,	7.985
Total,	<u>100.000</u>
Color of ash,	reddish gray.
Total of coke,	79.015

The shaft begins at a little below the place of the *Kelly seam* and exposes the *Twin*, *Barnet* and *Cook* seams. It was sunk to reach the *Barnet*, and the *Cook* is shown in the sump. The interval to the *Twin* is occupied mostly by shale, but it contains some sandstone. The *Twin seam*, as shown in the shaft, is a single bed varying in thickness from 18 to 20 inches. The overlying rock is sandstone which is separated from the coal by 2 inches of shale. The interval from the *Twin* to the *Barnet* is filled with sandstone except for 2 feet at the top, which is occupied by shale and fire-clay. The sandstone is hard but not coarse, though here and there it shows a few pebbles. The *Barnet coal bed* shows the following structure :

Bony coal,	0' 10" to 3'
Coal,	2' 10"
Slate,	0' 8" to 6"
Coal,	0' 10'

Below which comes fire-clay. A parting sometimes occurs in the upper bench at 4 inches from the bottom, between which and the slate is *gray coal*. The upper bench varies in thickness from 2' 6" to 2' 10" and the lower bench from 8" to 10". The coal from both benches is good but that from the upper bench is preferred. It is an excellent shipping coal and is much liked as a steam producer. The analysis by Mr. A. S. McCreath shows its composition to be:

Barnet coal from Cunard shaft.

Water,	0.570
Volatile combustible matter,	18.015
Fixed carbon,	78.078
Sulphur,	0.892
Ash,	2.445
Total,	<u>100.000</u>
Color of ash,	red.
Total of coke,	81.415

Which shows the coal to be of great excellence.

The Cunard synclinal shows a well-marked deepening southward, while the Cunard anticlinal becomes stronger in that direction. This southward dip of the basin is a serious inconvenience, necessitating a divergence of the gangways which are compelled to climb the anticlinals. The disturbances in this mine are noteworthy. The main gangway follows the strike as nearly as may be, but the coal is far from being level or from showing only the southward dip corresponding to that of the basin. It is thrown into a series of complicated folds, so that it is now above, now below the gangway. These troubles culminate in a fault of 30 feet, whereby the *Twin* and *Barnet seams* are brought to exactly the same level. Where the fault was first reached, a drift was set off on the *Twin*, under the impression that it is the *Barnet* abruptly diminished in thickness. The inferior coal soon exposed the error. The throw is on the west side and it was accompanied by a marked thrust,

for the *Barnet coal bed* is pushed into a fold on the east side, so that it curves over the gangway and comes down to it again at the line of fault. The coal has been removed from the east side of the fault for a distance of several hundred yards, but until recently that on the west side has been untouched. The main gangway was pushed along the fault for fully two hundred yards in what is termed the "rock tunnel." The polished sandstone wall is on its west side. As at that distance the fault showed no signs of decreasing, a "dip" was put down which soon reached the coal. The same fault was found in the Kelly mine on this property.

The *Cook coal seam* was reached in sinking the sump of the Cunard shaft. It is no longer exposed, but Mr. Wigton reports its structure as

Coal,	..	..	1' 6"
Clay,	..	..	0' 6"
Coal,	..	..	1' 6"

The coal is inferior and it has not been mined.

The *Barnet bed* is mined alongside of the run at about 700 feet further east by Dasher, Covalt & Hedden, the mine being known as the Covalt works. The structure of the bed and the character of the coal do not differ materially from the conditions observed in the Cunard shaft.

The Round Knob anticlinal, bounding this basin at the east, is reached about midway between the shaft and the first fork in the road.

But before the anticlinal is reached, a private road turns off southward and leads toward Round knob. Following this, one soon crosses the anticlinal and comes to a pit in which a *coal seam*, known locally as the *Pittsburgh coal bed*, was once prospected by Mr. Wigton. The dip here is eastward at 5 or 6 degrees. Mr. Wigton opened this bed on the opposite side of the hill, say 50 rods away toward the east, where he found it between 4 and 5 feet thick and dipping westward at nearly 30 degrees. This pit is now closed and no determination of the thickness or quality of the coal can be made. Following the road one finds only a petty exposure of black shale until at one fourth of a mile almost

along the strike he comes to a bed of limestone, 195 feet higher than the *Pittsburgh coal bed* and 12 feet thick as far seen. The dip cannot be determined accurately as the upper surface exposed is much weatherworn, but it appears to be not far from 6 or 7 degrees eastward. This is on Round knob, one of the highest points in the whole field. The limestone is dull blue, hard with irregular fracture and weathers yellowish white. It is quarried by Mr. Wigton for agricultural purposes, and appears to answer very well.

At a little way further east and 40 feet above the limestone, Mr. Wigton has prospected a small *coal seam*, which is 16 inches thick and yields very bad coal. It shows very little dip either along the entry or in a room which has been driven for nearly 20 feet, so that it and the limestone quarry must be very near the central line of the basin. The knob rises to nearly 100 feet above this *coal bed*.

As the basin is narrow and the dip not more than 5 to 7 degrees on its western side, the interval between the *Pittsburgh coal bed* and the limestone cannot be more than 200 feet. The interval from that *coal bed* to the *Kelly seam* is nearly 500 feet, the former being a few rods on the east side of the anticlinal and the latter a few rods on the west side.

The limestone and the upper *coal bed* are exposed on the southern side of Round knob but the outcrop of the *Pittsburgh coal bed* has not been observed there.

Returning now to Six-Mile run and following it above the Round Knob anticlinal, one comes to the axis of the Round Knob trough at barely 20 rods west from the fork of the road beyond what is known as Wigton's row. This basin is shallow and does not carry the *Barnet coal* under the run. The *Kelly coal bed* was opened at one time south from the road, but the quality of its coal proved to be inferior.

The next anticlinal is crossed by the road just above the railroad tank-house. The succeeding basin, the North Point, has a very short west side, which barely suffices to carry the *Barnet coal bed* under, and the sandstone overlying that bed is well shown in the hill side south from the road. A marked southward dip is shown in this basin by

the relative place of the *Barnet coal bed* near the road and in a boring made at a little way south by Mr. Mitchell for the Kemble Company. The axis is crossed very near the first bridge above the tank-house and the *Barnet coal bed* is again in the road at the lower end of North Point village.

A shaft was sunk on the *Barnet* at the lower end of North Point and on the north side of the run. Work was stopped in this shaft several years ago. Mr. Mitchell reports that the coal varies from 18 to 22 inches with 3 to 4 inches of bone on top. The lower bench has wholly disappeared. A boring from the bottom of the shaft reached the *Cook coal bed* at 50 feet, but instead of coal only smut or carbonaceous clay was obtained.

The *Barnet coal bed* is mined at North Point by R. Maher, lessee from Dr. Rummel. In his mine the bone coal varies from 4 to 6 inches and the coal from 2 feet to 2 feet 6 inches; but the lower bench is wanting here also. The coal is very good, apparently equaling that from the Cunard shaft.

At one time the *Cook seam* was mined near the bridge over the run immediately above North Point. It is said to be nearly 7 feet thick, but some complication exists in the bedding, which makes the work difficult and the mine has been abandoned. It is in such condition that the nature of the trouble could not be ascertained. An opening in the *Kelly seam* at a little way south from the run was worked until recently. The bed shows the following structure:

Coal,	.....	1' 6"
Clay,	.....	0' 4"
Coal,	.....	1' 6"

as reported by a miner formerly engaged in the pit. The coal from both benches is fairly good but not equal to that obtained from the *Barnet*.

A slight anticlinal is crossed by the run near the bridge and the Edgehill anticlinal is crossed near the Welsh church. The *Barnet coal bed* has been mined beyond the bridge and the lower beds have been mined between the bridge and the first crossing of the run; but no details were obtained respecting these as the works have been idle for some time.

The Reed Wilson anticlinal lies beyond the next crossing of the run and passes very near a small cluster of houses at the eastward bend of the road. It carries the coals well up in the hill and it doubtless brings up the Pottsville, though no good exposures were found to decide this question with certainty. Beyond this the rocks dip eastwardly and the *coal beds* come down in succession, so that within a short distance the *Kelly coal bed* has been opened by Mr. Jenkins. The *Speer bed* is shown above it in the hill.

Exposures practically cease after the Jenkins opening has been passed. The massive sandstone above the *Speer bed* comes down to the road before the end of the railroad track has been reached. There the axis of the Jenkins synclinal seems to be crossed. Thence fragments of the sandstone, coarse, with conglomerate layers, are numerous to some distance beyond the last crossing of Six-mile run. Almost midway between this crossing and a corduroy bridge over a small tributary to that run, the road crosses a low ridge. Fragments of the sandstone are abundant on both sides of the ridge but are wanting for a little way below the summit, so that here is evidently the axis of another anticlinal. Thence the rocks dip eastwardly and the dip is well shown at the corduroy bridge. At that bridge the road begins the ascent of Broad Top mountain. The synclinal is reached at the first bench and thence to the summit beyond Mr. Swope's house, the dip is westward. This dip is distinctly shown by exposures in the road as well as by a coal pit just west from Mr. Swope's house. At that house, one is on the summit. Exposures on this planed-off surface are as poor as in the wilderness between Swope's and the Jenkins openings. But here is reached the great Broad Top anticlinal, which brings up the Pottsville and forms the ridge, in which the streams head.

The eastern basins are very shallow, though the general rise of the surface might lead one to suppose the contrary. The great sandstone at the bottom of the Jenkins basin is fully 700 feet above Riddlesburg, while in the second basin it is carried to below the altitude of that place. In the Jenkins basin, the *Kelly coal* at the pit mouth is very near

the bottom of the trough and is more than 650 feet above Riddlesburg; whereas in the trough of the first basin it is barely 40 feet above the same place. These determinations are barometric.

Few developments have been made in the coal field north from Six-Mile run. Outcrops of the lower coals have been found along the western edge of the field and some openings in the *Kelly coal bed* have been made in the Fairplay and Cunard basins; but none of these has attained to any importance and the region is practically undeveloped within Bedford county. The important developments are in Huntingdon county.

A road leaves Six-Mile run just east from Wigton's row, say half a mile above the Cunard shaft, and leads thence to Sherman or Ground Hog valley, passing by the head waters of Long and Sandy runs. The Tank-House anticlinal is crossed by this very soon and the eastward dip is seen at the southward bend of the road. The Edgehill anticlinal is crossed very near where the Long Run road turns off, for at a little way beyond that the rocks are shown in a side cutting with an easterly dip of 30 degrees. The next axis is crossed at a little beyond the lane leading to John Figard's house, but the exposures are too indistinct to permit any closer approximation to the place. Still another axis is crossed near Sandy run, but no exposures were found beyond that until the Pottsville has been passed and the Mauch Chunk was reached in descending to Ground Hog valley.

The summit of the ridge between Sandy and Sherman's valley is nearly 1200 feet above Riddlesburg; but the summit, where crossed by the road leading from the valley to Hopewell is barely 900 feet above that place.

Returning and taking the road leading down Long run, one soon comes to the Kemble Company's farm, and at a short distance beyond finds old openings in the *Kelly* and *Barnet* below the road. The measurements made here are as follows:

1. <i>Kelly coal bed</i> ,	3' 6"
Coal,	0' 10"
Bone,	0' 2"
Coal,	2' 4"
Black slate,	0' 2"
2. Interval,	80'
3. <i>Barnet coal bed</i> ,	4'
Bone,	0' 6"
Coal,	3' 6"

The dip is insignificant and it may be disregarded, so that the interval as given is very nearly accurate. No exposure of the rocks occupying it could be found.

No further exposures were seen until the Cunard basin was reached. The Cunard anticlinal, insignificant on Six-Mile run, is here strong and its line is shown distinctly by the outcrop of the great sandstone which overlies the *Speer coal bed*. A road turns southward toward Long run almost at the place where the sandstone marking this axis is reached. This leads to the slope driven by the Kemble Company.

That company bored at this place to the *Kelly coal bed*, which, according to the driller, indicated a thickness of 4 feet 6 inches. A slope was begun at the outcrop, where the bed is but 4 inches thick. The dip is 30 degrees and the slope at the time of examination was 250 feet long. The coal thickens very slowly, for at the end of the slope, it is but 1 foot 4 inches, as reported; the slope being half full of water, no measurement could be made. The *Speer coal seam* is shown above the slope and a trial pit showed its structure to be

Coal,	1'
Shale,	2'
Coal,	1'

The vertical distance to the *Kelly bed* is 55 feet, the dip being 30 degrees.

The Cunard anticlinal is well shown at a short distance below the slope. Its dips are 55 degrees westward and 25 degrees eastward.

Returning to the road and following it down to the mouth of Long run, one finds few exposures and these are so widely separated that it seems impossible with an inaccurate map to make any determination of their relations. An abandoned

coal opening was seen not far from the mouth of the run, but the exposure does not show the structure.

One is in the second basin at the mouth of Long run. Turning up Sandy run here and following the railroad, the School-house or Sheaver's creek anticlinal is reached at the first sharp bend in the road. Its triple character is shown in the railroad cut and the middle fold is neatly shown on the county road. No exposures whatever occur in the next or Duval basin, either on the railroad or on the county road. The Duval anticlinal is not well shown either on the railroad or on the county road, but its place is near the railroad bridge over Sandy run near Dick's house. The great sandstone makes a fine cliff above the railroad on the west side, with a dip of 20 degrees, while on the east side it is imperfectly shown further up the road. The Fairplay or Coaldale basin shows nothing in the neighborhood of Sandy run and no prospecting seems to have been done here. The Cunard anticlinal is crossed just below the dump of the Harriet Lane mine, very near the second run entering Sandy from the south, and beyond that one comes into the basin holding the Wigton or Cunard shaft and the Kemble Company's slope.

The Cunard basin is shallow here, scarcely sufficing to carry the *Kelly coal bed* below the run. The dip diminishes abruptly eastward; on the immediate slope of the anticlinal it is 45 degrees, but, at a distance of only a few yards in the Harriet Lane mine, it becomes almost nothing. The whole rise of the coal bed from the bottom of the basin to the Cambria mine, nearly 1,600 feet further east, is but 150 feet. The section in the Harriet Lane mine is

1. Shale,	8'	,
2. <i>Kelly coal bed</i> , upper division,	1' to 4''	
3. Clay,	10'' to 1''	
4. <i>Kelly coal bed</i> , lower division,	5'	

The shale, No. 1, is nearly 20 feet thick, as shown in the air shaft, and above it comes the great sandstone, which is bluish gray, very hard, and more or less irregularly bedded.

The upper division is double and shows a thin parting midway. The interval to the lower division is variable as is shown in the section and this is a source of much anxiety

in mining. Frequently the interval, for long distances, is not more than an inch, sometimes even less, so that the roof is extremely insecure. The shale overlying the bed is soft and much slickensided, thus adding to the insecurity. In the morning the roof may appear altogether secure, while in the evening it may be ready to fall. Rolls are common but they do little injury, the largest cutting out but 12 inches of the coal. The structure of the lower division as shown in this mine is as follows:

<i>Coal</i> , upper bench,	1' 10"
<i>Coal</i> , bearing in bench,	0' 7"
<i>Coal</i> , middle bench,	1' 5"
<i>Coal</i> , lower bench,	8' 0" to 1'

The upper bench occasionally becomes 2' 2" thick. It contains good coal but here and there 4 inches of gray splint coal, inferior to the rest, occurs at the bottom. The bearing-in bench averages about 8 inches, but sometimes it is 14 inches while at others it is only 4 inches thick. It is always parted at a little above the middle. Its coal is good but somewhat softer than that from the upper bench. The middle bench yields excellent coal, but the lower bench is very inferior and is not mined. It is badly broken by binders of slate and pyrites, while nodules of pyrites are common.

In a heading driven up the dip on the west side of the basin, where the dip is 45 degrees, the effect of the pressure is very marked. The coal is from 1 to 16 feet thick and is polished so as to be too slippery to stay in the wagons if they are well loaded. This coal is not marketable.

The same bed is mined on the opposite side of the basin at the Cambria mine of the Juniata Valley Company. The structure of the lower division in this mine is as follows:

<i>Coal</i> , upper bench,	2' 3"
<i>Coal</i> , bearing-in bench,	0' 7"
<i>Coal</i> , middle bench,	1' 8"
Bone,	0' 1"
<i>Coal</i> , lower bench,	2 3"

A non-persistent layer of bony coal occurs in the upper bench at 10 inches from the top. The character of the top and middle benches is the same as at the Harriet Lane mine and the lower bench is practically worthless, as it contains much pyrites both in binders and nodules.

A sample of the coal from the upper and middle benches, analyzed by Mr. A. S. McCreath, showed the following composition :

Water,	0.575
Volatile combustible matter,	16.515
Fixed carbon,	76.720
Sulphur,	1.230
Ash,	4.960
Total,	<u>100.000</u>
Color of ash,	cream.
Total of coke,	82.910

Some coke made on the ground from this coal was sent to Mr. McCreath for analysis. Its composition is

Water,	1.015
Volatile combustible matter,	2.297
Fixed carbon,	86.782
Sulphur,	1.928
Ash,	7.978
Total,	<u>100.000</u>
Color of ash,	Red.

The main gangway of this mine enters well up on the west side of the Round Knob anticlinal, which has a N. 30° to 32° E. direction. To gain drainage, the gangway gradually climbs the anticlinal and the roof soon shows a dip of 20 degrees. A heading leads across the crest of the fold, which is reached in a long room designated on the company's map as Prosser's room. On the east side of the anticlinal, a dip of 14 degrees is shown. The northerly dip of the basin is well seen in a room which follows the strike almost accurately, but must be drained by a syphon. The roof in this mine is excellent and rooms have been driven 30 feet wide. These were deserted several years ago, but the timbers are still sufficient to sustain the roof. This is a black slate rock, whose thickness has been ascertained only in the Prosser room where a fall showed it to be 20 inches thick with the upper division of the *Kelly coal bed* resting on it. This division has been drilled through here ; its thickness is given as 5 feet and the coal is said to be good. The interval between it and the main division below seems never to be so small here as it is at the Harriet Lane mine.

The overlying sandstone is well shown on the south side of the run opposite this mine. A *coal bed* was found in a well on that side at 18 feet below the surface; it may be the *Twin seam*.

No further exposures were seen along the run; but on the road leading from the Cambria mine across the ridge to Sherman's run, the Round Knob anticlinal is well shown. No further exposure was found until the Pottsville was reached near the crest of the ridge. The coals rise rapidly southward for, at the crest of the ridge barely one mile from the Cambria mine, one is 500 feet above the mouth of that mine and hardly 100 feet above the bottom of the Pottsville.

Returning now to the mouth of Long run, one comes to the great upper sandstone in the second basin as recognized on Six-Mile run. In descending Sandy run from this locality to the first through-cut above Hopewell on the railroad, the following section was made out:

1. Sandstone,	Not measured.
2. Concealed, 55 deg., 25', hor. dist.,	20'
3. <i>Speer coal bed</i> , 10" to	10'
4. Concealed, estimated, 15', hor. exp. at 56 deg.,	12'
5. Flaggy sandstone, estimated, 30', hor. exp. at 50 deg.,	23'
6. Massive sandstone, estimated, 25', hor. exp. at 45 deg.,	17'
7. <i>Kelly coal bed</i> ,	Blossom.
8. Dark shale,	4'
9. Flaggy sandstone, 20', hor. exp. at 40 deg.,	13'
10. Massive sandstone, not fully shown, 75', hor. exp. at 40 deg.,	48'
11. <i>Twin coal bed</i> ,	Blossom.
12. Flaggy sandstone, 30', hor. exp. at 18 deg.,	9'
13. Concealed, 20', hor. exp.,	8'
14. <i>Barnet coal bed</i> ,	Blossom.
15. Sandstone, 100', hor. exp. at 20 to 40 deg.,	50'
16. <i>Cook coal bed</i> ,	Blossom.
17. Sandstone, 190', hor. exp. at 43 to 38 deg.,	121'
18. <i>Coal bed</i> , 2" to	0' 10"
19. Shale,	18'
20. <i>Coal and shale</i> ,	0' 2"
21. Shale,	6'
22. Sandstone,	20'
23. Shale,	5'
24. Sandstone,	5'

The sandstone, No. 1, forms a bold wall extending along the strike below the mouth of Long run. It weathers very
17 T².

light gray, but the fresh surface is bluish gray. The dip is eastward at 56 degrees.

The *Speer coal seam* is mined by Dotson & Blatchford almost opposite to the row of stone houses belonging to the Cambria Iron Company. The structure is exceedingly variable but the succession seems to be

1. Carbonaceous shale,	0' 4"
2. Clay,	1'
3. Coal,	2'
4. Clay,	1' 6"
5. Coal,	1'

But this measurement was made in the adit and the relative thicknesses of the divisions answer only for the spot where the measurement was made, for they show marked differences. The dip near the mouth of the pit is 56 degrees, at 100 yards inside it is nearly vertical, while at 200 yards it is 68 degrees.

Near the crop, the coal of No. 3 is 4' 3" thick, but within a few yards it diminishes to 1' 3" to become 2' at 200 yards. There a room has been driven to about 30 feet above the gangway. The coal of No. 3 is 2 feet thick at the bottom of this room; Nos. 3 and 5 are both shown at a few feet higher where the section is

3. Coal,	2'
4. Clay,	1' 6"
5. Coal,	1' 2'

But within 2 feet the lower division increases and the whole thickness becomes 5' 9"; while still higher the clay disappears and the bed is 10 feet thick. Some streaks of clay were seen in this thicker part of the bed but they are not persistent. The pocket shape is not the only evidence that the bed has been subjected to enormous pressure. The slips are often separated by but a fraction of an inch and in some of the larger pockets the bed appears to be made up wholly of lenticular pieces. These are glazed as though they had been varnished; and often the coal can be distinguished from the equally glazed roof-slate only by breaking. This coal is a good fuel and finds a ready sale for local use. The glazing of the planes makes mining very easy, so that in the larger pockets, one man can bring down 5 tons a day

without excessive labor. This ease of mining, however, hardly compensates for the danger incurred.

The interval between this and the *Kelly bed* is shown in the run.

The *Kelly coal bed* is no longer mined. An old opening was found just above the bed of the run and another, which is extensive, was seen well up on the face of the hill. The dip is gentler in the upper than in the lower pit. These pits have been abandoned for more than 15 years and no information could be ascertained respecting the thickness of the bed. The coal, as far as could be determined from fragments lying about the old dumps, closely resembles that seen in the Dotson mine. This coal became known as "looking-glass coal" and owing to its appearance was wholly unmarketable, so that the mines had to be abandoned.

No. 8, 9, and 10 are shown in the bed of the run. No. 9 is flaggy and contains some vegetable stems. No. 10 is not fully exposed, but a great part of the interval is occupied by hard gray sandstone.

The *Twin coal bed* is no longer mined. An old opening was seen above the run and another, probably only a prospect hole, was found on the run "bottom." The coal seen on the dump is glazed and badly slipped, so that it is not marketable. No direct information respecting the thickness could be obtained but it is said to be not far from 2 feet.

The *Barnet coal bed* also was mined, but its coal, like that from the other beds, proved unsalable. The interval to the *Cook seam* is not fully exposed. The distance between the two beds is given only approximately and may be ten feet too small. It is filled for the most part with sandstone, whose dip varies from 20 to 40 degrees. The *Cook coal bed* underlies a massive sandstone and old openings in it were seen both north and south from the run. The coal is like that from the other beds.

The sandstone, No. 13, is the upper plate of the Pottsville conglomerate. Its dip varies from 43 to 38 degrees, but is somewhat difficult of determination as the rock is cross-bedded. This sandstone varies from coarse to very fine-grained, is hard, light gray to bluish gray. It is well shown

immediately above the first cut and the lower part is exposed in the cut where it describes a sharp double anticlinal in a horizontal distance of barely 40 feet. This is the first axis of the Broad Top field, the Grey's Run anticlinal further south. The sandstone rises rapidly westward after passing the cut and it can be followed by the eye as it ascends the mountain side to where it describes a gentle anticlinal almost opposite to the first house below the cut. This anticlinal, which appears to be little more than an interruption of the dip, evidently represents the secondary axis observed in the Mount Equity mine, where it splits the first basin of Six-Mile run.

The *coal bed*, No. 18, is shown in the cut, where it varies from 2 to 10 inches. It is in layers one inch to one fourth of an inch thick, which are separated by thinner layers of shale. The shale, No. 19, is dark brown, concentric and contains much nodular iron ore. The streak of *coal* underlying it is sulphurous and consists of films of *coal* in shale. The sandstone, No. 22, is gray, coarse, micaceous, and contains comminuted fragments of carbonized wood. Coaly matter occurs in the underlying shales and *Cordaites* was recognized in the lowest member of the section, which is a gray flaggy sandstone more or less ferruginous.

This section ends with the last exposure along the branch railroad. The lowest plate of the Pottsville is not shown in place, but its fragments cover the mountain side and show that it contains layers of very coarse conglomerate.

The Mauch Chunk shales are ill-exposed along the county road leading down the run. Near the railroad they describe a double anticlinal. The Pocono sandstone underlies the borough of Hopewell, where it dips eastwardly at 65 degrees. In digging a well at the track level in Hopewell Mr. Isaac Evans found 4 inches of coal at 14 feet from the surface or about 200 feet below the top of the series. Some of the coal is very good. The Mauch Chunk iron ore has been found in a well sunk above the railroad. This is the same with the ore formerly mined on the opposite side of the river to supply Hopewell furnace

Mauch Chunk continues along the county road between

Hopewell and Riddlesburg to the sharp bend in the road, where the Pottsville is reached. The junction of the two groups is well shown as is also the upper 100 feet of the Mauch Chunk; but no *coal bed* was seen either in the Pottsville or in the Mauch Chunk. The passage is gradual and gray sandstones alternate with red shales. The anticlinals seen in the Mauch Chunk south from Hopewell are shown on this road, but are more distinct in the railroad cuts between the two villages.

CHAPTER XI.

The Region between the Bedford County line and Sideling Hill.

This embraces the townships of Union, Brush Creek and Wells, all in Fulton county. 'Entering by way of Leasure's or Sideling Hill gap through Town Hill, one comes into

Union township

near the Maryland line.

Catskill rocks are dipping south of east in the gap, but the axis of the Emmaville synclinal is crossed by Sideling creek at a few rods below J. Northcraft's store, or at less than half a mile due east from the county line. The Pocono, which forms the crest of Town hill, has been removed from that ridge near this gap; but toward the State line, it is caught again and Town hill regains its height. Erosion has carried away the Pocono from both sides of the shallowing trough for nearly a mile north from the gap, and for nearly a mile further on the east side. Still further northward, Trough creek has worn out a valley near the synclinal line, which separates Negro mountain on the east side from Town hill on the west. This separation continues almost to McKee's run.

The road, leading across Whip Cove, affords no exposures until it approaches Buck Lick run, where some red and

yellow shales belonging at the bottom of the Catskill or the top of the Chemung were seen, still dipping westward; but the Whip Cove anticlinal is crossed immediately beyond the run. No further exposures of any sort were found between this point and the foot of Sideling hill, where one comes to Pocono.

The whole region south from this road to the Maryland line is neatly planed off by erosion, so that the surface lies well for easy farming; but the soft Catskill rocks have yielded to the weather and the rounded hillsides afford no exposures. The whole area is practically uncleared for three miles from Greenpoint post-office and is still covered by pine forest, which conceals everything effectually.

Turning at the cross-roads east from J. Deneen's house and going thence northward toward McKee's gap, no exposures were found until near the German Lutheran church, where the dip is distinctly north-west, showing that the axis of the anticlinal has been crossed. The dip continues in that direction as is shown by many short exposures. The Pocono is reached at a little way above J. McKee's house, where the dip is north-west. But the axis of the Emmaville synclinal is crossed very near where the road bends north-westward and thence to the top of Town hill the dip is south-eastward. Erosion has made a deep notch on the west side of the Pocono in this wind gap, by which the Bedford and Hancock road crosses the ridge, so that the sandstone outcrop lies considerably east from the summit of the pass. Southward from the road, the east and west outcrops of Pocono make separate ridges, a tributary to McKee's run continuing the division made further south by Trough run. Northward, the Pocono ridge is much bolder and increases in height for fully a mile to the "locking," where Ray's hill and Town hill separate and the Mauch Chunk first appears in the deepening Emmaville basin.

Going eastward from McKee's gap one finds few exposures. The dip is westward at the G. L. Fisher fork in the road, but it is south-east at a few rods beyond the School-house. Beyond this the dip is flexuous, there being a sharp westward dip where the road bends southward toward the run;

but it is south-east again at D. Deneen's house. A short sharp synclinal and an equally abrupt anticlinal are passed before the township line is reached under Sideling hill. Some fragments of *brown hematite* and oxide of *manganese* were seen on the hillsides in this gap, which evidently come from the Pocono of the ridge.

McKee's run enters Tonoloway creek at the head of this gap, which is known as Deneen's gap. Along the creek northward from the gap, only occasional exposures of Catskill shales are shown. The road enters

Brush Creek township

within a mile and a half from the gap. The cove narrows rapidly northward, as owing to the diminishing strength of the Whip Cove anticlinal, the Pocono outcrop of Town hill approaches that of Sideling hill, so that, at little more than 6 miles north from the township line, the "locking" of the two mountains is reached and the Pocono crosses the arch. The axis of the Whip Cove anticlinal is crossed by Tonoloway creek near the Winter's school-house, where it seems to be as abrupt as in Union township.

The road crossing Sideling hill leaves the creek just below the Winter school-house, but it affords no exposures until within one third of a mile of the summit, where it turns abruptly toward the south-east. There, the lower sandstone of the Pocono is shown in a side-cutting. Some very carbonaceous black shale was seen higher up, and at the top of the ridge is the coarse upper sandstone of the group, still dipping eastward.

The same road crosses Town hill on its way to Emmaville and reaches the Pocono of that ridge at somewhat more than 100 rods below the summit; but the exposures are very indefinite and the exact base of the group could not be ascertained. In like manner, on the north-eastern slope of the ridge, Pocono *débris* covers the surface, so that the eastern edge of the Mauch Chunk could be fixed only approximately. It is not far from 100 rods south-east from R. P. Stille's house, or about one mile south-east from Emmaville. Thence southward, Town hill and Ray's hill approach and the basin

becomes very narrow at the township line, while the Mauch Chunk practically ends before the "locking" is reached.

The axis of the Akersville anticlinal becomes distinct at a very little way north from where this road first reaches the Mauch Chunk, and its line is marked by a low ridge gradually increasing in height northward to Akersville, beyond which it grows more rapidly to the Bedford and Chambersburg pike. The axis of the Emmaville synclinal is crossed before one comes to Emmaville and at a short distance north from that village, the road is on the Mauch Chunk limestone. The light colored limestone is burned for agricultural use, but the red beds are thought to be of little value. The limestone is somewhat silicious, but it is useful as an amendment to the heavy soil derived from the Mauch Chunk shale. The gray limestone is from 3' to 5' thick.

A petty fold follows the foot of Ray's hill and the road from Emmaville to Gapsville crosses it frequently. The Pocono comes down near to the road, which touches it at a little way south from the Brush Creek gap. Thence northward to Akersville the road lies in Mauch Chunk shale.

No exposures were found on the road leading from Brush Creek gap over Sideling hill into Bethel township until the Pocono was reached at 75 rods from the first fork in the road. There one is on the ridge of the Akersville anticlinal. The rock is not exposed in place, but its position is indicated by an abrupt steepening of the road and by the sharpness of the ridge. Fragments of the rock are abundant and belong almost wholly to the highest bed of the group. Thence to Sideling hill, the road follows a ridge covered with Pocono fragments. The Mauch Chunk of the Duval basin ends north from this road, there being, so far as one can judge from the topography, only Pocono southward to the other road. But the space is unbroken wilderness and detailed examination would be useless, as the rocks in place are wholly concealed by a deep cover of Pocono débris.

Returning to the fork of the road and going northward along the west side of the Akersville ridge, one finds few exposures. The Pocono lies east from the road all the way

to beyond Akersville, but occasionally, as between the houses of W. Walters and A. B. Akers, it extends almost to the road. Akersville is on Roaring run, a branch of Little Brush creek rising in the side of Sideling hill. On the road leading up this stream one comes to Pocono just beyond the first fork and that rock continues to the sharp southward bend, where the road again descends to Roaring run. There one comes to the Mauch Chunk of the Duval basin. The valley of this stream is divided northward by a prong of Pocono extending to half way between the Bedford pike and Roaring Creek gap; this is on the Sprowl anticlinal. Exposures are indefinite on the east side of the basin and the limit of Mauch Chunk is given on the map only approximately.

A road leads from Akersville northward to McIlvaine's hotel on the Bedford pike. The westerly dip continues along this road to beyond Mrs. Sproat's saw-mill, though it is interrupted by an insignificant fold, which was not traced northward, but it seems to represent the McIlvaine anticlinal. The axis of the Emmaville synclinal passes between the saw-mill and the next house, for at that house the dip is eastward at nearly 50 degrees, as is well shown in two places near the third of Mrs. Sproat's houses. The Mauch Chunk limestone is shown just beyond that house. A narrow fold similar to that seen south from Brush Creek gap was seen here. The road lies in Mauch Chunk to beyond the last of Mrs. Sproat's houses, where it passes over to the Pocono, in which it remains to the pike.

Following the direct road from Akersville to the pike, one rides on Mauch Chunk to within 60 rods of the northward bend and the Pocono is reached very near J. D. Jackson's lane. A narrow anticlinal was seen in the Mauch Chunk just before the Pocono was reached, which answers to one seen on the Roaring Run road. The dip of Mauch Chunk north from Akersville is westward at nearly 40 degrees. This road reaches the Bedford pike at say 100 rods west from J. Ensley's house. The axis passes very near that house and thence the dip is eastward. But exposures

soon become indefinite and the place of the next axis eastward, the Sprowl, could not be fixed closely.

Following the pike westward from the forks, one soon finds a good exposure of Pocono dipping eastward. The axis of the eastern division of the Emmaville basin is marked by a bold hill north from the pike, which breaks down abruptly southward and is lost at once in Brush Creek valley. The next or McIlvaine anticlinal is crossed by the pike at a little way east from McIlvaine's hotel, so that near the house the dip is westward. The synclinal between it and the Griffith anticlinal is insignificant, so that almost from McIlvaine's hotel to the summit of Ray's hill the dip is eastward.

The old State road leaves the pike at McIlvaine's. Taking this road and going northward, no exposures were found until very near the township line. Just beyond P. Ensley's house, the road passes into

Wells township

And the easterly dip on the Akersville anticlinal is shown immediately beyond the township line. No further exposures were found until the forks of the road had been passed. A synclinal axis is crossed very near the forks for, at W. Sprowl's house, the dip is N. 32° W. at 20 degrees. The Sprowl anticlinal is deeply cut by Wooden Bridge creek, which heads near the pike under the Akersville anticlinal and makes a long exposure of Catskill. The road remains on Pocono to the sharp bend about 100 rods beyond Sprowl's house, where it passes over to the Catskill. This rock continues to beyond the township line. Mr. Sprowl has discovered a thin *bed of coal* in the lower part of the Pocono, which is exposed at several places in the ravine of Wooden Bridge creek. It is from 3 to 4 inches thick and its *coal* is thought to be very good.

Returning to the forks and taking the road leading into Wells valley, one finds much Pocono débris but no good exposure until near D. B. Nail's house, where the rock is dipping westward on the Akersville anticlinal. The country is uncleared on the east side of the road and one cannot de-

termine with any degree of certainty how far southward the Mauch Chunk extends on that side. That group is reached along the road at somewhat more than 50 rods above B. Greenland's house.

In passing up Oregon creek one is in Mauch Chunk certainly to the township line, but Pocono lies very near Oregon Creek valley on both sides. Mauch Chunk *iron ore* occurs on Oregon creek, but no determination of its quantity has been made. The same ore occurs on Elbow run. It is a *brown hematite* and is accompanied by oxide of *manganese*. The tongue of Mauch Chunk, occupying the space between Elbow run and Oregon creek, lies in the trough between the Akersville and Griffith anticlinals, the McIlvaine fold having disappeared abruptly north from the State road.

Entering Wells township from the west by way of Wishart's gap, one comes at once to Sideling Hill creek and is in Mauch Chunk rocks. Exposures are very imperfect, but the synclinal between Broad Top and Wells tannery anticlinals is crossed by the road at a little way west from D. Horton's house. Just above that house, a road leads northward to the Wishart mine in the *Barnet coal bed*. The section of the bed as exposed here is

1. Coal,	0' 1"
2. Clay,	1' 3"
3. Bone,	0' 4" to 6"
4. Coal,	2' 8" to 2' 4"
5. Bone,	0' 8"
6. Coal,	0' 5" to 6"

Mining is carried on somewhat extensively here to supply so much of Fulton county as can be reached through the gap made by Sideling Hill creek; some of the coal has been hauled to McConnellsburg. The best fuel comes from No. 4, in which the coal is brilliant, rather soft, and easily mined. One man can bring down between 3 and 4 tons per diem. The lower parting is merely slate with streaks of coal; it is used as the "bearing-in," but its slack is too slaty and contains too much pyrites to be of any value. No. 1 is useful as a parting in the slate, enabling the miner to heighten the gangway without trouble, while at the same

time it appears not to weaken the roof in the rooms. The coal of No. 4 was sampled and sent to Mr. A. S. McCreath for analysis. He gives the composition as follows:

Barnet coal from Wishart mine.

Water,	0.635
Volatile combustible matter,	16.220
Fixed carbon,	78.884
Sulphur,	0.826
Ash,	3.475

Kidney iron ore, blue and "shelly," occurs at 2 to 3 feet under the coal in lenticular nodules, some of which weigh several hundreds of pounds.

The *Kelly coal bed* was opened here at one time, but the location was badly chosen and the roof was very thin, so that the pit was abandoned. No direct information respecting the bed could be obtained but the thickness is said to be not far from 5 feet. The hill is high enough to catch the *Speer coal bed* at many places, and the presence of the bed is proved by fragments of its coal. The bench of the *Twin seam* is distinct above the Wishart mine, as is also that of the *Cook bed* further down the hill. But no attempt has been made to test either of these seams. The *Mount Savage coal bed*, or interconglomerate seam, has been opened in a prospecting pit at a little way below the mine, where it is said to be 10 inches thick. The rock overlying it is, for the most part, a moderately coarse grained sandstone, very light gray, some of it almost white. A similiar rock is shown below the coal, but toward the bottom this contains a very coarse layer, which was not seen in place. Its fragments are numerous and some of the pebbles are as large as pigeons' eggs.

West from this mine, the Broad Top anticlinal carries the Pottsville on its crest. The synclinal of the Wishart basin passes at barely 200 yards east from the mine and a petty anticlinal follows it, as is shown on the face of Broad Top mountain. South from Sideling Hill creek, a high mountain rises, which is continuous topographically with Ray's hill. A deep recess occurs on its northern side, filled with

Mauch Chunk and marking the course of the Wishart basin. The mass of the mountain is Pocono.

Following the creek an exposure was found at about one fourth of a mile east from D. Horton's house, which shows an westward dip of 30 degrees. No further exposure was found until very near T. W. Horton's house in Wells Tannery village. There the dip is eastward at from 60 to 80 degrees, and the beds belong very nearly at the bottom of the Mauch Chunk. South from the creek, the Wells' Tannery anticlinal is bold and carries a ridge of Pocono from the creek into the mountain mass of Ray's hill, where its place is very distinct at a little way north from the Bedford and Chambersburg pike. Northward it diminishes rapidly, though retaining enough strength to cut off the Coal Field abruptly. The Pottsville rim of the Broad Top enables one to trace out the structure here with comparative ease.

The basin lying east from the Tannery anticlinal is shallow. The axis is very near the tannery and the Mauch Chunk limestone is brought up again at the first fork of the road. The next anticlinal passes near Mr. H. Wishart's house. Southward from the creek, its place is marked by a ridge of Pocono rapidly increasing in height southward. Mauch Chunk occupies the shallowing recess between it and the Tannery anticlinal.

Going eastward from Mr. A. Wishart's house, one finds a distinct eastward dip in the shales at the cross-roads beyond G. Stewart's house, which is very marked at the run beyond T. Griffith's house. No further exposures, aside from some insignificant exhibitions of Mauch Chunk shale, were found before reaching the dam of Anderson's mill, where the lowest beds of Mauch Chunk are shown on the west side of the stream with northwestward dip; while Pocono comes down to the stream at the mill, where it is shown in place. Thence to Wallace's mill, the road lies in Pocono, of which a cliff was seen on the west side of the creek, and the dip at the mill is 17 degrees W. N. W. Mauch Chunk was reached again just below the mill, and thence to New Grenada the road lies in that group.

The westward dip is shown along the road to N. W. Hor-

ton's house and rarely exceeds 15 degrees; but, at that house, the rate becomes steeper and a synclinal is crossed before Roaring run is reached, for an easterly dip is shown just beyond that stream. The road remains on the west side of the synclinal until it crosses Foster's run, beyond which it passes again to the east side and reaches Pocono at the village of New Grenada. The lower part of the Mauch Chunk is shown there and contains the limestone seen near Wells' tannery.

A boring for oil was made at New Grenada some years ago. Mr. Stunkard of that village gives the following as the record:

1. Shale,	18'
2. Limestone and shale,	25'
3. Sandstone,	100'
4. <i>Coal and shale</i> ,	9'
5. Sandstone,	70'
	<hr/>
	223'
	<hr/>

The tools became fast at the depth given and the work was abandoned. Nos. 1 and 2 are Mauch Chunk, the remainder of the section is Pocono. The driller reported three beds of *coal* in No. 4, separated by thin slates, giving in all of pure *coal*, 8 feet. The *coal* is said to have been pumped out and submitted for trial to the village blacksmith, who is said to have reported that it is superior to that obtained from the *Barnet coal bed* on Broad Top. These coal beds, if present should be exposed near the head of the gap, but no prospecting for them has been done notwithstanding the blacksmith's flattering report.

The creek breaks through Sideling hill at New Grenada. Pocono debris covers the hillsides, so that a detailed section cannot be obtained. The upper or great sandstone of the group is exposed for a horizontal distance of 1600 feet with a dip of 23 degrees, thus giving as its thickness about 625 feet. Below this is the next sandstone, with ferruginous conglomerate and pockets of shale. Some prospecting for *iron ore* has been done here.

Mauch Chunk *iron ore* appears to be persistent along the the west foot of Sideling hill for several miles south from

New Grenada and lumps of *brown hematite* occur abundantly on the surface. Many of the lumps on the mountain side come from the disintegration of the Pocono, which holds occasional pockets of *brown hematite* in its upper beds. But no attempt has been made at any locality to ascertain the quantity of ore, there being no ore diggings in Wells township.

Broad Top mountain is deeply notched by Gibson and Roaring runs, but north from the latter stream, it extends eastward until it is cut off by the Griffith anticlinal. Some attempts have been made to open the *Barnet coal bed* on the eastern outcrop opposite New Grenada, but the rapid westerly dip prevented drainage and the prospecting was quickly abandoned. *Kidney iron ore* occurs abundantly along the edge of the mountain and it may belong to the deposit underlying the *Barnet coal bed*. But this region is still a wilderness, covered by dense forest and cut only by petty streams with shallow channel-ways.

CHAPTER XII.

The Lewistown valley.

Within Fulton county, the Lewistown valley includes Bethel, Belfast, Licking Creek, and Taylor townships with much of Thompson at the south and of Dublin at the north. For convenience of description, however, the whole of Dublin will be given in the next chapter. The western boundary of this area is the well-marked Sideling hill, extending from the Maryland line northward into Huntingdon county; but the eastern limit, as taken here, is wholly arbitrary.

Bethel township.

As one enters this township from the west by way of Deneen's gap, he finds the Pocono dipping westward and very imperfectly exposed. The axis of the synclinal passes very near to the line between this and Union townships.

The Catskill comes up at a few rods within Bethel township with a westward dip of 60 to 70 degrees, and it is occasionally shown at the roadside, while very fair exposures occur along Tonoloway creek. The sandstones of the group are well shown where the road crosses the creek beyond J. Daniel's house, but thence to very near Franklin mills the exposures are very bad. The upper conglomerate of the Chemung evidently passes very near to the school-house beyond the creek, but it is not shown in place and Black Oak ridge alone determines its position. Yellow shales of Chemung age are frequently shown in the road as Franklin mills are approached and at that place one is in the dark olive flags and shales of the Portage group.

A high ridge is cut by Tonoloway creek immediately below Franklin mills, which marks the place of a strong anticlinal. In going north-east over this ridge, the Chemung yellow shales are shown crossing the arch. The synclinal beyond is at barely half a mile from where the road leaves Tonoloway creek. The dip on each side of the anticlinal as shown in the road is from 25 to 35 degrees, the rate varying abruptly.

Turning southward at the first fork of the road, two thirds of a mile from Franklin mills, one is in yellow shales carrying thin beds of olive sandstone. Exposures are very poor and the Portage flags are shown indifferently. The top of the Hamilton is reached at somewhat less than three fourths of a mile from the fork in the road. The laminated sandstone and gray shales are poorly exposed and fair exposures were found only when the road came to the Marcellus shales. The upper division, drab fissile shales weathering yellow, is well shown and passes very gradually into black shales, which lie along the west foot of Tonoloway ridge. As at nearly every other locality in the district, these shales contain thin irregular layers of limestone.

Tonoloway ridge, the western boundary of Pigeon Cove, has Oriskany sandstone on its western slope but consists mainly of the compact limestones of the Lower Helderberg. Oriskany is not exposed near the road, having been washed away in the valley of White Oak run, but the Lower Helder-

berg limestones are shown immediately beyond the stream. Thus far the dip, though somewhat irregular, has been north-westward, but a sharp anticlinal was seen at P. Gordon's house, less than half a mile further north. Thence eastward the exposures are very poor, but there seems to be an anticlinal just east from Mrs. Snell's house.

Iron ore occurs in loose fragments along the western side of Tonoloway ridge, but whether it belongs to the Lower Helderberg or to the Marcellus could not be determined.

Returning to the fork of the road, two thirds of a mile north-east from Franklin Mills and continuing northward, one rides on Chemung yellow shales to the Christian church. The *lower conglomerate* of the Chemung is shown near J. Bernhard's house, where the dip is distinctly westward. The synclinal is crossed between the church and D. Spencer's house, and the *lower conglomerate* is shown with eastward dip near the church. Turning westward at the next fork, one soon crosses the Franklin Mills anticlinal at D. Winter's house. The *lower conglomerate* is shown on a low ridge east from the house, while the *upper conglomerate* is shown just before reaching L. Hill's house. It is exposed in the road, is coarse, but evidently not more than 10 feet thick. It forms the back bone of Black Oak ridge, which shows its place from the Maryland line northward to the Bedford and Chambersburg pike. The red and yellow shales marking the upper part of the Chemung are shown at the hilltop beyond Mr. Hill's house, where they are dipping westward at 70 degrees. Thence exposures are fragmentary, but they show that the Catskill rocks continue with decreasing dip almost to the sharp northward bend in the road at nearly a mile north from A. Layton's house. Pocono forms the east side of Sideling hill from this point and the axis of the synclinal is reached before the summit for there the dip of the Pocono is eastward at 23 degrees.

A sharp anticlinal was seen near J. Giffin's house, at half a mile west from Hill's and the same axis was seen at barely half a mile north from the road or at a little way south from Barnett's run.

Returning to the fork of the road at Winter's house and 18 T².

going eastward, one comes to the lower conglomerate of the Chemung near Mrs. R. Mason's house where its dip is westward, showing that the axis of the synclinal has been crossed. The yellow shales continue from Mrs. Mason's northward to the township line, but a road turns to the east at half a mile from Mrs. Mason's and leads into Pigeon cove. On this the Portage flags and shales are soon reached and the top of the Hamilton is shown just west from M. Hill's house. The Genesee shales and the laminated sandstones are fairly well exposed, but the Marcellus shales are wholly concealed. No further exposures were found until the Oriskany was reached in ascending Tonoloway ridge.

The western outcrop of that rock on the Pigeon Cove anticlinal is shown at the Alpine school-house on the crest of the ridge, and the massive Lower Helderberg limestone crops out finely behind it. These limestones describe an anticlinal midway between the crest and A. Hess' house. No exposures were found beyond this until the limestone was reached on the opposite side of the cove with easterly dip. The rock is burned here for agricultural purposes by M. and E. Fisher. A sample was taken from this place, which was analyzed by Mr. A. S. McCreath with the following results:

Lower Helderberg limestone from M. and E. Fisher

Carbonate of lime,	93.117
Carbonate of magnesia,	2.043
Oxide of iron and alumina,	0.600
Sulphur,	0.075
Phosphorus,	0.006
Insoluble residue,	4.110

The outcrop of Oriskany is reached at the summit of Stillwell's ridge, which forms the eastern boundary of the cove.

Returning to Franklin mills. There one is on the Portage, which continues along Sideling Hill run for nearly half a mile above its mouth. Exposures are indefinite thence, as the numerous runs in the south-west corner of the township have broken up Black Oak ridge, while along the streams a dense growth of vegetation so conceals the rocks that, at very many localities, details can be obtained only

at the expense of much time and labor for which they would afford but slight compensation.

On Tonoloway creek, the Portage flags make massive cliffs and in general appearance bear great resemblance to the Catskill sandstones, for which indeed they might easily be mistaken; but their color is olive brown and the shales are olive to brown, while here and there a band of yellowish-gray shale or sandstone is shown. The rock supports a liberal growth of lichens. A distinct anticlinal is shown at the forks of the road below the Mills tannery, with dips of 60 degrees westward and from 70 to 90 degrees eastward. A close synclinal occurs at a few rods further east and the dip is westward at 60 to 70 degrees until the first crossing of Tonoloway, where it falls to 15 degrees. The dip is more abrupt at the next crossing and an anticlinal is crossed at I. Covalt's house, which has an east dip of 65 degrees. A similar dip is shown at the next crossing, but within a few yards the dip is vertical. Thus far the creek has flowed amid Portage flags, but, at the fifth crossing below Franklin mills, it enters the Hamilton which is very imperfectly exposed.

The Oriskany of Tonoloway ridge is reached just beyond the first road leading southward, but no exposure was found showing either the dip or the general character of the rock. Loose fragments of the sandstone show that the rock varies from coarse-grained to conglomerate. The Lower Helderberg limestone forms the body of the ridge but it is not exposed in detail. A very distinct anticlinal was seen opposite P. Gordon's house and the synclinal beyond it was crossed at the fork of the road north from Warfordsburg. Three petty folds pass through Warfordsburg. Only the shaly portion of the Lower Helderberg is shown in the cove, but the middle portion comes down on the eastern side at the road forking east from the village, while the massive limestones are shown near the house belonging to W. W. Kirk's heirs, where the dip is eastward at only 16 degrees. Another anticlinal occurs in Stillwell's ridge, the eastern boundary of the cove, which, however, seems to continue

but a short distance northward, as the ridge is broken here and Tonoloway flows northward through it into

Thompson township

where it soon turns eastward to the junction with its north branch or Little Tonoloway at somewhat more than two miles north from the Maryland line.

After crossing the creek at the head of the gap, the road ascends Stillwell's ridge, which is much higher near the Maryland line than it is further north. Oriskany sandstone is reached at the summit, but it has been so badly broken by erosion that no details can be gathered. The base of the Hamilton is not shown, but on the road leading to Brewer's mill on Tonoloway creek, the drab to dark fissile shales weathering yellow are shown. These contain slabs of limestone and dip eastward at 25 to 30 degrees. The exposure is fairly good to just beyond the old school-house, but thence there are few exposures until as one passes down into the gorge of a small tributary to Tonoloway creek, he comes to the Portage flags and shales, dipping 35 degrees where first seen but 60 degrees near the creek. This dip falls to 20 degrees near the head of the mill-pond. The character of the rock is the same as in Bethel township. Some of the layers are fossiliferous but the forms are indistinct, only *Rhynchonella* and crinoids stems having been recognized. Good collections could be made here, but blasting would be necessary as the rock is badly decomposed for a considerable distance from the surface. Eastward from the mill the dip increases rapidly and becomes 65 degrees at the mouth of Little Tonoloway. In ascending Timber ridge, the highland between Tonoloway and Licking creeks, one soon comes to the yellow shales and the *lower conglomerate* is seen in the road. It is thin, evidently not more than 5 feet, but it is distinct as a bluish-gray sandstone, only moderately conglomerate and with films of quartz crossing the bedding. The *upper conglomerate* is not shown in place but its line is marked sufficiently well by the first summit of Timber ridge. The yellow and red shales at the top of

the Chemung are reached just beyond the cross-roads at the summit.

Still going eastward, one finds only shales in the lower part of the Catskill until Younker's run is reached, but beyond that stream the laminated sandstones of the group are shown dipping eastward at from 50 to 70 degrees. The easterly dip still prevails at D. Cook's house on the second summit of the ridge. No exposures were found between the second and third summits, but the dip is changed in this interval, for, on the road following the third ridge, the dip in a road-cutting directly north from J. Zimmerman's house is 70 degrees westward and the rocks are Chemung. The *Chemung lower conglomerate* is shown on a lane leading to Licking creek, where it is associated with yellow shales. The Portage flags form massive cliffs nearer the creek, are olive to brown and have a dip of from 70 to 90 degrees westward.

On the main road, one reaches the ridge of the *upper conglomerate* at the old church and cemetery. The rock is, for the most part, a hard bluish-gray sandstone with layers of very coarse conglomerate; some ferriferous beds are closely related to the conglomerate here, so that many of those living in the neighborhood have supposed this rock to be the same with the Pocono of Scrub ridge. No good exposures were seen beyond this to R. Hollingshead's house, where the road turns sharply north-east and exposes well the Chemung shales, red, brown, gray and olive; but the Portage flags are concealed in the "bottom" of Licking creek. The region lying beyond that creek, or the western slope of Dickey's mountain, will be described in the succeeding chapter.

Crossing Licking creek, the road follows a ravine eroded in Hamilton to the first fork of the road. Turning westward here, one comes to the top of the Hamilton near the school-house, but exposures are indefinite and the line was not fixed with any degree of certainty. The Chemung shales are shown imperfectly as one approaches S. Hess' mills, and the sandstones between the *conglomerates* are well exposed in the creek bluff opposite the mills, where they

dip westward at 65 degrees. Beyond Licking creek, the road ascends Timber ridge and reaches the *upper conglomerate* at P. Peck's house, where its fragments are very abundant and show the same features as at the Old church, two miles further south.

Exposures are very indefinite along this road as it crosses Timber ridge. An easterly dip was seen near Mrs. S. Peck's house but its relations could not be ascertained. Occasional petty exhibitions of Catskill shale are shown until near M. Gordon's house, where the variegated red and yellow shales of the Chemung are reached. The *upper conglomerate* is shown at the summit of the first ridge, say 70 rods beyond the house while the *lower conglomerate* is reached at the cross-roads on the second ridge.

Still following this road, which leads to Stillwell's ridge and thence into Pigeon cove, one finds the yellow shales, here and there fossiliferous, until beyond W. Bishop's house, where the Portage shales and flags are reached. The flags predominate toward the base so that at the creek they form cliffs in which the dip varies from 10 to 15 degrees. These flags continue beyond Little Tonoloway to Mrs. F. Covalt's house, where one comes to the Genesee shales, dark but weathering bluish or yellowish white and containing some *nodular iron ore*. The Hamilton gray shales are shown beyond, but they are very thin, so that the yellow and ashen shales are reached before one comes to J. T. Bailey's house. Thence everything is concealed along the road leading over Stillwell's ridge until the Oriskany is shown almost directly west from Mr. Bailey's house. This rock continues to the summit of the ridge but is shown in place only where the road first touches it.

Returning to J. T. Bailey's and going northward, one is in the Hamilton until he crosses the township line into

Belfast township

at nearly two miles south from Needmore. The road remains in Hamilton to Needmore, touching the Oriskany only as it comes to Barnett's run. Beyond that run, the Marcellus shale is shown and fragments of the limestones

are scattered in the road. The shales are partially exposed in the bank as one enters Needmore. Eastward from the little village, they are shown occasionally where they have been turned up in making road; but the exposures serve only to prove the presence of the shales. Hamilton continues to the Tonoloway at the east and imperfect exposures northward show that it extends in that direction for nearly a mile and a half from Needmore, as the creek flows along the course of the Pigeon Cove anticlinal.

On the road leading across Timber ridge, the Portage flags are reached immediately beyond Little Tonoloway, where they are exposed in a bluff with an easterly dip of 38 degrees. They continue along this road to within 50 rods of the first house, where one comes to the yellow shales, of which the exposures do not show the dip. Some fragments of gray sandstone were seen on the first ridge. The *lower conglomerate* forms the second ridge and is shown where the road descends to a run at one third of a mile from the Ridge school-house. It is coarse conglomerate and dips eastward at 35 degrees. Above it are yellow shales and red sandstones, the latter very hard and streaked with quartz films. The *upper conglomerate* is at the crest of the next ridge but it is not shown in place. The rock is very compact and blocks containing 8 cubic feet are numerous on the steep hillside looking toward Licking creek. Red and yellow shales overlie this conglomerate and are shown occasionally as the road descends the ridge.

The Catskill is reached at the foot of the hill opposite Mrs. McKee's house and an exposure immediately beyond Licking creek shows an eastward dip of 30 degrees. Many exposures of flaggy sandstones were seen along the road leading from the creek over Scrub ridge. The dip slowly increases to 35 degrees and so remains until near J. B. Kline's house, where it suddenly becomes 55 degrees. Thus far sandstones have predominated but thence shales prevail, mostly deep red but showing here and there a few streaks of yellow.

Pocono débris is reached within 100 rods east from Kline's, and very soon the road is made difficult by half exposed

blocks belonging to the coarser parts of that group. Some *iron* and *manganese* ore was seen in loose fragments near W. McEldowney's house, where the road begins to ascend the mountain. This doubtless belongs to the Pocono. The sandstone is not shown in place until within 60 rods of the township line, where it is dipping eastwardly at 56 degrees. The axis of the Scrub Ridge synclinal is very near the township line, for there the westward dip is very distinct. The Pocono area barely touches Thompson township at the south.

Northward along the side of Scrub ridge, the Pocono area widens, so that on the road leading across the mountain from McConnellsburg the base of the group is reached very near the lane leading to A. Dishong's house. Between that point and the summit of the ridge the group is fairly exposed in a succession of bluffs, and at the summit the road passes through a shallow cut in the upper sandstone. There the rock is conglomerate, cross-bedded and the dip is between 20 and 23 degrees eastward. The Catskill rocks are exposed below Dishong's lane. They contain little sandstone until Licking creek is reached at Geo. Moreton's, where an exposure of laminated sandstone shows an easterly dip of 40 degrees.

The road crosses Licking creek at Geo. Moreton's house. Turning southward there towards Joe's run, one comes quickly to the ridge of the *upper conglomerate*. Some laminated sandstone on the east side of the hill shows a dip of 43 degrees E. S. E. The conglomerate, as shown near the crest of the hill, is in two plates, 5 and 2 feet respectively, separated by 2 feet of shale, while at nearly 50 feet lower is a third plate, 5 feet thick, the interval being occupied by yellow shale. The top of the ridge is reached at the fork of the road. Yellow shales are there, but just beyond are some red, streaked sandstones, very hard but not well exposed. The *lower conglomerate* comes down to Joe's run near J. K. Wink's house, where it is exposed to the thickness of 3 feet.

Beyond that run, variegated shales, red, yellow, drab and olive, were seen, but before the summit between Licking

creek and Foster's run is reached the yellow shales predominate. The Portage flags are shown near Foster's run, and, at Mrs. Truax's house, they show an eastward dip of 60 degrees. This dip continues to Foster's run, where it suddenly becomes vertical and the Pigeon Cove anticlinal is reached with westward dip of 65 degrees. The yellow shales are shown immediately beyond this; but the synclinal is crossed near E. Mellott's saw-mill, for the yellow shales are dipping eastwardly at 35 degrees by J. Mellott's house and the Portage flags are brought up again at M. Starr's house; the Franklin Mills anticlinal is crossed here by the creek and the flags are dipping westward at 65 degrees immediately above where the road crosses the creek. Thence no exposures were found until Sipes Mill post-office was reached, where the creek breaks through Black Oak ridge, made by the *upper conglomerate* of the Chemung.

Turning off at J. Mellott's house, one mile below Sipes Mill post-office, and going southward, one finds few exposures aside from yellow shales until the creek is reached where the Portage flags are exposed. The Hamilton appears to reach fully a mile and a half north from Needmore, but the limit is indefinite as erosion has been active. Southward from Needmore on the road leading to Warfordsburg, the Oriskany of Tonoloway ridge is reached immediately beyond Barnett's run, that being the northern termination of the exposure on the Pigeon Cove anticlinal. The road is on Oriskany to J. Garland's house, but there it passes to the Hamilton, which is wholly concealed. Barnett's run flows northwardly here in a narrow valley eroded amid Hamilton. The Portage flags are reached where the road crosses the run and there they dip westwardly. An anticlinal is crossed opposite Mrs. E. Garland's house with an easterly dip of 25 to 30 degrees and a westerly dip of 75 degrees; and a second fold is crossed just west from where the road passes in Bethel township. This has an easterly dip of 35 degrees. The westward dip could not be made out satisfactorily, but it is sharper than the other.

Westward from Needmore, one comes to these folds be-

yond Hart's mill, but the immediate fold passing directly below Franklin Mills and through Mr. Winter's house is not exposed. Black Oak ridge is reached near Mrs. Clark's saw-mill, beyond which is a gentle anticlinal involving the *upper conglomerate* of the Chemung. The petty fold observed in Bethel township is shown near A. Hess' house, at a mile and a half south-west from Mrs. Clark's. Going northward from Mrs. Clark's, one finds many fragments of the *upper conglomerate* and the Catskill is not reached until one passes Mr. A. Truax's house. An exposure of the laminated sandstone, belonging to that group, near Mr. E. Palmer's house has a westerly dip of 70 degrees, while at Mr. N. Truax's, the next house northward, the dip is only 50 degrees. No further exposures were found for nearly a mile. Some sandy *brown hematite* was seen near Mrs. Palmer's, which in all probability has been washed down from the Pocono.

The stream flowing past Palmer's marble-shop, the main fork of Cumming's run, heads in Sideling hill north from the "lockings" of Town and Sideling hills. The mountain is split here by the forks of this stream, which have eroded a deep valley along the anticlinal, deep enough to catch some Catskill. A similar erosion has been made by another branch of Cumming's run flowing past T. Runyan's house. The main fork of Little Tonoloway is reached at Mrs. Mel-lott's saw-mill, beyond which is the road leading across Sideling hill to Gapsville. Turning westward on this road, one finds Catskill shales, red with occasional streaks of yellow and gray, to nearly 200 rods from the mill. There the Pocono is reached, dipping westward at about 30 degrees, the exact dip being somewhat uncertain as the exposed rock is much cross-bedded. The synclinal is reached at about 50 rods further and the easterly dip is 25 degrees.

The streams forming this fork of Little Tonoloway have eroded a deep basin along the Whip Cove anticlinal, so that the eastern ridge is a synclinal and the western a monoclinel. The two ridges are distinct from this locality southward to beyond Palmer's gap, but thence the saddle is insignificant. No Catskill was seen on this branch of Little Tonoloway,

but the depth of the gorge is such that that group must be there. A similar excavation north from the road made by the other fork of Little Tonoloway keeps the ridges distinct for nearly two miles further north.

Between Mrs. Mellott's mill and Sipes Mill post-office, an insignificant anticlinal was seen within 100 rods east from Wink's mill and a westerly dip of 50 degrees was seen near J. Mellott's mill about a mile north from Sipes Mill post-office.

The road leading north from that post-office follows Black Oak ridge. The *upper conglomerate* is very hard and coarse, many of the pebbles being more than an inch long. The larger pebbles are flat, the thickness being barely one third of the length. At two miles from the post-office the road passes into

Licking Creek township.

A road leaves the ridge road at a few rods from the township line and leads eastward to Licking creek. Yellow and variegated shales prevail along this road, but no definite exposure was found until near S. Traux's house, where the Portage flags are shown dipping westwardly. This is evidently the easterly slope of the Franklin Mills fold. No further exposures were seen along this road until near Licking creek, where the ridge of the *Chemung upper conglomerate* is well defined. The Timber Ridge road, which in Thompson and Belfast townships, follows this ridge, leaves it in northern Belfast and before reaching Licking Creek township has passed to the ridge of the *lower conglomerate*, which it follows almost to Sideling Hill branch of Licking creek. The creek itself cuts through the upper ridge at the mouth of Sideling Hill branch and through the lower ridge near the Sipes School-house.

The *lower conglomerate* is not shown in place along the ridge, but fragments litter the surface and show well the character of the rock. It is decidedly coarse, many of the pebbles being larger than a chestnut. Exposures of Catskill occur in little bluffs along Licking creek near the southern line of the township, where the dip appears to be from

45 to 55 degrees. The cross-bedding of the sandstones is so marked that the dip cannot be determined accurately from the limited exposures.

The Sideling Hill branch road crosses Licking creek below the mouth of Patterson's run and leads thence across Scrub ridge. As on the other roads crossing this ridge, one can fix the base of the Pocono only approximately, but it is not far from 100 rods above S. Dishong's house. Much *brown hematite* of excellent quality occurs along this side of Scrub ridge, and fragments occur very near the Pocono, so that most probably the ore belongs within that group. Very handsome limonite has been obtained at about two thirds of a mile north from Dishong's and the quantity is supposed to be considerable, as many of the fragments are very large.

Immediately above where the Timber Ridge road reaches Sideling Hill branch, an exposure of Portage flags was seen, in which the dip is eastward at 40 degrees. The dip seems to be somewhat steeper at the first hollow, but it soon becomes gentler, for it is but 28 degrees at a little way below the saw-mill. The rate quickly increases, becoming 35, 40, 45, and at Dishong's mills the Black Log anticlinal is crossed, its westerly dip being from 80 to 90 degrees. There may be another fold at a little way down the creek, but the exposures are not sufficient to settle the matter. The dip is reversed above Dishong's mills before the road crosses the run, and a fine exposure above that shows the flags dipping eastward at 45 degrees.

The single fold representing the Franklin Mills and Pigeon Cove anticlinals is crossed above the old saw-mill and the flags go under with westerly dip of 65 degrees at the next little run entering from the south. The yellow shales are shown here. The dip quickly decreases and at the next house, half a mile beyond, the dip is but 20 degrees. Within a few rods the road enters Black Oak ridge and the *upper conglomerate* is crossed at D. D. Mellott's house, where it is imperfectly exposed in place. Sideling Hill branch is formed near J. Strait's house by streams rising at the foot of Sideling hill, but none of these gashes the mount-

ain side or makes more than a slight notch in the Pocono outcrop at its crest. The road leading west from Strait's house lies in Catskill, but the exposures are very indifferent and do no more than merely to suggest the dip. The road leading over the mountain to Akersville was not followed to the township line as the exposures, so far as followed, proved to be very incomplete. The road following the foot of the mountain northward to the Bedford pike lies wholly in Catskill. Exposures of the laminated sandstones occur at each tributary to Sideling Hill branch and the dips vary from 55 to 60 degrees westward. But all exposures cease at somewhat more than a mile south from the pike, which is reached at Saluvia post-office.

The Pocono outcrop on Sideling Hill becomes irregular near the pike and that road follows the long gorge of Sindeldecker's run, which extends westward beyond the township line, while the Pocono does not cross the pike until that line has been reached. The Catskill shows a westward dip of 70 degrees very near that line. Coming eastward, the Whip Cove anticlinal is reached at about 1500 feet from the township line and the Catskill shows a distinct south-eastward dip at a little further, while the Pocono outcrop recedes southward, making a cove in the mountain. Northward, the axis appears to pass east from the Pocono outcrop, so that the ridge immediately north from Sindeldecker's run must consist of the synclinal between the Whip Cove and the Sprowl anticlinal. The dip on the east side along the pike could not be determined satisfactorily owing to the character of the exposure. The synclinal is reached quickly and at the house indicated on the county map as belonging to Benedict, Lyons & Co., the dip of the Catskill beds is westward at 25 degrees.

No exposures were found beyond this point until the Stone house was passed. Thence to Saluvia, many exposures show the dip to be westerly at from 30 to 35 degrees. But the rate increases rapidly east from Saluvia, for an exposure near W. A. Speer's house shows a dip of 65 degrees. A similar dip was seen at Mann's store, where one comes to Black Oak ridge and the *upper conglomerate* of the Che-

mung is exposed behind the house. The immediately underlying rocks are red shales and sandstones.

No further exposures in detail were observed until near the Greenhill church, where the Portage flags are shown with irregular westward dip, 45, then 35 and at the end of the exposure 45 degrees again, with good reason to suppose that a still higher rate of dip is reached. The fold representing the Pigeon Cove and Franklin Mills anticlinals is crossed just beyond this exposure, for at 10 or 12 rods further an exposure shows an eastward dip of 50 degrees, which quickly decreases to 20 degrees. The yellow shales are shown on the hilltop and remain in sight to beyond the Stone church, nearly 100 rods east from the other. There the dip changes and at 75 rods from the Stone church the Portage flags are shown again but dipping westward at 65 degrees. This westward dip continues to beyond J. Daniel's house, meanwhile becoming gentler. But an anticlinal passes not far east from Mr. Daniel's house, for at the next exposure the flags are dipping eastward at 38 degrees. The dip becomes steeper and at about 125 rods west from Harrisonville it becomes irregular. Three small folds are shown between this point and Harrisonville, which with the Daniel's fold evidently represent the Black Log anticlinal.

No exposures were found in Harrisonville, but the flags are well shown immediately beyond Licking creek with an eastward dip of 43 degrees. The top of the flags is reached just west from the sharp bend in the road. Beds of yellow shale from 2 to 20 feet thick appear in the upper part and the passage to the yellow shales is gradual, though sufficiently distinct. The ridge of the *lower conglomerate* is crossed at about 30 rods west from J. M. Clark's house and that of the *upper conglomerate* is at the forks of the road beyond that house. Both are coarse, but the pebbles are larger in the lower bed. The Catskill rocks are reached at Patterson's run, where they are dipping at 33 degrees; other exposures beyond indicate a dip of 38 degrees. The Catskill beds are poorly shown eastward from this along the pike and the Pocono is reached very near the township line. The exposure is incomplete there, but the Pocono crosses the

pike and extends northward for somewhat more than one fourth of a mile.

A road leaves the pike at J. M. Clark's house, west from Patterson's run and leads northward toward Knobsville. This road leaves the *conglomerate* ridge at once, but soon becomes parallel with it. A lane leading northward leaves the road at somewhat more than 100 rods beyond J. Gaster's house and soon rises upon the ridge, which it follows for nearly a mile. An anticlinal lies west from the road and passes very near to W. Valance's house.

The upper edge of the Chemung is reached on the road at the School-house and the Catskill is touched there, but thence to the cross-roads the road lies in Chemung. The easterly ridge of the *Chemung upper conglomerate* enters the township at nearly a mile north from the pike and is reached in Dublin township by this road at a little way beyond the township line. Turning northward at the cross-roads, the conglomerate ridge on the west side of the Scrub ridge synclinal is reached again at the township line where the road passes into

Dublin township,

so that the Catskill barely enters this township.

No exposures were seen between the township line and Licking creek, but abundance of red shale and fragments of conglomerate appears on the surface. An anticlinal and synclinal have been crossed before Licking creek is reached, for at the creek, the *lower conglomerate* is shown with S. S. E. dip. Thence are yellow shales covering a high ridge between Licking creek and the petty tributary on which is D. T. Chestnut's saw-mill. The main fold of the Black Log anticlinal passes through this ridge, for at Chestnut's mill, the flags are shown with north-westerly dip of 35 degrees. No good exposures were found beyond this until one begins to climb Clear ridge, which is but the continuation of the Black Oak ridge of Bethel, Belfast, and Licking Creek townships. The *upper conglomerate* is shown at the crest of the ridge, where the road enters

Taylor township

at Hustontown on the Old State road. Going south-westward from Hustontown to the township line, one is on the Catskill or the upper edge of the Chemung all the way, while from the township line to the Old State road at the foot of Sideling hill, Catskill alone is seen. The rapid diminution of the Pigeon Cove anticlinal within a short distance north from the Bedford pike permits the Catskill to cross it, so that Black Oak ridge bends north-eastward to Hustontown and the area of Catskill immediately south from the State road extends almost wholly across Taylor township.

Exposures are wanting along the State road as it descends Sideling hill until it approaches West Dublin post-office. The Pocono outcrop lies at a long distance from the road and that rock is not reached in Taylor township. The gorge of Wooden Bridge creek is broad and deep, the stream heading under the Akersville anticlinal within Brush Creek township, so that the Catskill rocks are exposed in it far beyond the west line of Taylor. The axis of the Sprowl anticlinal should pass not far from the township line, but Pocono débris conceals everything.

At West Dublin post-office, the Catskill beds are shown dipping westward and they are the surface rocks to the Stevens school-house, where the yellow and red shales of the Chemung are reached. The Jack's Mountain anticlinal is crossed within three or four rods of G. S. Chestnut's house. There some fragments of *conglomerate* were seen on the surface but the bed must go under at some distance north from the road. Nothing was seen south from Wooden Bridge creek, so, that in all likelihood, the Chemung terminates at a very little way from the State road. Catskill is reached again along the road at not more than 25 or 30 rods east from Chestnut's house and thence the eastern dip is distinct to beyond D. Laidig's house, half a mile from where the road crosses Wooden Bridge creek. The dip at that house is 45 degrees and the synclinal is at not more than 50 rods further east. The westerly dip is not abrupt and at the School-house west from Hustontown it is but 20 degrees. Thence it be-

comes steeper until at Hustontown it becomes almost 50 degrees. Yellow sandy shales alternating with red begin at the School-house and continue to the top of Clear ridge. The beds at the School-house contain no fossils but have much comminuted woody material.

The ridge of the *Chemung upper conglomerate* passes through the eastern edge of Hustontown and continues in an almost direct line northward into Huntingdon county. Following the ridge, one comes to the first fork in the road at a mile and a half from Hustontown. On this, the Catskill is reached at the bend below P. Dyke's house, and, thence to within 100 rods of Wooden Bridge creek, exposures occur frequently. At first the dip is 45 degrees, within half a mile it is but 25 degrees and thence towards the creek the decrease in rate continues. The synclinal is very near the creek. No exposures were found beyond the creek, until after passing S. Lander's house. In descending to Elder's branch, the Catskill sandstones were seen dipping eastward at 35 to 40 degrees.

The red and yellow shales of the Chemung are shown just beyond the stream and the *upper conglomerate* is crossed by the road within 70 rods north from J. Dorn's house. Thence to the Taylor Chapel cross-roads, only yellow shales and fragments of conglomerate were seen. The Jack's Mountain anticlinal evidently passes very near the curve of the road 50 rods west from the chapel, but exposures are poor and indefinite, so that its place could not be fixed. Thence, the whole surface is littered with fragments of the two *conglomerates* and the place of the beds cannot be determined. The upper bed, however, is certainly passed before the Berkstresser cross-roads has been reached.

Turning northward there, one rides in Chemung rocks to opposite C. Corbin's house, where an anticlinal is indicated, though the exposures do not afford any details. At Sideling Hill creek, one is in Catskill. This stream, rising on the side of Broad Top, flows northwardly through Wells township and breaks through Sideling Hill at the county line. The walls of the gap are Pocono. Mr. Berkstresser reports finding *coal* at the mouth of the gap while making

excavations for his mill-dam. The bed is said to be 5 inches thick. Thence to the mill, the dip of the Catskill beds are 35 degrees W. N. W.

Descending the creek, one is in Catskill to beyond Berkstresser's mill, below which the Chemung beds are reached. A narrow anticlinal, with exceedingly abrupt dip on the east side is shown in the creek bank at 10 or 15 rods below the ford opposite O. Osborn's house; thence the rocks rise eastwardly to the bridge over the creek.

Turning southward here, one is in Chemung variegated shales and the *lower conglomerate* is reached at the bend north from A. Bollinger's house. The Jack's Mountain anticlinal is crossed between that house and the U-shaped bend in the road, where the Portage shales are shown. Thence to the cross-roads, there are no exposures, but just beyond one comes to the *upper conglomerate*. Yellow and red shales are shown east from this to J. Winegardner's house with a dip of 30 degrees. *Spirifera disjuncta* occurs in these shales at Winegardner's lane. Some yellow bands occur beyond this place, but they contain no fossils.

The dip becomes very gentle as one approaches Wooden Bridge creek and the synclinal is not more than 100 rods west from the stream. Thence no exposures were found until the *upper conglomerate* of the Chemung was reached at Clear Ridge post-office, where the road passes into Dublin township.

CHAPTER XIII.

Ayr, Todd and Dublin townships, with part of Thompson township, Fulton county.

This area includes the Silurian rocks of Fulton county, aside from those of Pigeon cove, and holds also the strip of Devonian in the eastern and northern portions of the Scrub Ridge synclinal.

Thompson township.

Dickey's and Cove mountains unite in the southern part of this township, so that, where Licking creek passes into Franklin county, the Oriskany and Lower Helderberg are shown curving round the end of the mountain. Detailed exposures of Oriskany, Lower Helderberg and Clinton are almost wholly wanting along the face of Dickey's mountain; the dip is abrupt and the short slope is covered by a thick coat of Medina debris.

A bed of Lower Helderberg limestone is quarried by Mrs. Stilwell Johnston at a little way from Licking creek and somewhat more than two miles north from the Maryland line. This quarry is the main source of supply for the farmers of Timber ridge. A sample was sent to Mr. A. S. McCreath for analysis and he reports the composition as follows:

Mrs. Stilwell Johnston's limestone from No. VI.

Carbonate of lime,	87.357
Carbonate of magnesia,	2.346
Oxide of iron and alumina,	1.930
Sulphur,	0.020
Phosphorus,	0.002
Silicious matter,	8.430
Total,	<u>100.085</u>

The limestone is reached again along the creek at A. Shives' place and it has been opened on S. Simpson's property near the northern line of the township.

Fragments of coarse *brown hematite* were seen at several localities, but no other ore appears to occur in the Clinton. No bits of *fossiliferous ore* were found.

The Cove creek road passes into

Ayr township,

and lies amid Lower Helderberg for nearly a mile, beyond which it follows the Hamilton to half a mile beyond the Elysian mills. The former group is well shown on the Humbert and Harris farms. The Oriskany is shown opposite the Elysian mills, where it is richly fossiliferous and, according to Mr. James Pott, so calcareous that it yields a lime good enough for ordinary building purposes.

The black shales of the Marcellus are poorly shown everywhere, but the yellowish and ashen shales overlying them are exposed near the Old Hanover furnace, immediately above the mills. Turning westward here, one finds Hamilton continuing to the first lane, where the Portage flags are reached. These continue along this road to the first fork with dip varying from 75 to 90 degrees eastward. Nearer Scrub ridge on this road, explorations have been made for iron ore by J. Gordon, who has obtained *micaceous ore* from the lower part of the Pocono. The ore occurs usually in thin streaks, one fourth to one half inch; occasionally bunches are found, but in these, ore and sandstone are so mixed as to render the whole worthless. Leaving this road at the first fork, less than a mile from the Elysian mills, and going toward Scrub ridge, one rides on the yellow shales belonging between the *conglomerates* until the road bends sharply toward the mountain. There the ridge of the *upper conglomerate* is crossed and the road soon enters the Catskill, which is imperfectly exposed near J. Bivan's house. Thence no exposures were found until the Pocono was reached with inverted dip at the sharp double curve in the road.

Returning now to the Elysian mills. The Lower Helder-

berg is exposed at the foot of Dickey's mountain where its quality is as variable as at other localities, some of the beds being of superior excellence while others are decidedly magnesian. A cellular *brown hematite* occurs in the Clinton at, say, two thirds of a mile from the mills, where it was mined, 35 years ago, to supply the Old Hanover Iron Works, which stood very near the site of the mills. Very little ore was taken out and there is reason to suppose that the bed was not found. For the most part this ore is coarse and silicious, containing only about 38 per cent. of iron. The mining was abandoned because the ore proved to be very inferior. Small fragments of *fossiliferous ore* are sometimes found on the mountain side but no bed has been discovered.

The Lower Helderberg is exposed at a few rods north from the mills, where it dips eastward at 55 degrees. Thence to the forks, the road is on the lowest beds of the Hamilton. Turning eastward there, one comes quickly to the Lower Helderberg, which is quarried for lime by J. Hare on Big Spring run just below where the road reaches that stream. The rock is exposed for two or three rods, but thence all is concealed for nearly 500 feet, when the Medina is reached dipping eastwardly at 60 to 80 degrees. The concealed interval is not sufficient for the Lower Helderberg, so that a part of that group with the whole of the Clinton has gone down in the fault.

Going westward toward the Cove tannery, one finds the Hamilton beds ill-exposed, but, just below the tannery dam, the Portage flags are shown with inverted dip. These are shown also at the woolen factory, where they are vertical or pushed 10 degrees beyond it. They continue in sight to beyond the mouth of Spring Valley run, where the Hamilton beds are reached. These extend to the line of fault, where they abut against the limestones of the Lower Silurian immediately below the grist-mill at Webster Mills post-office. The Hamilton dips westward at 65 to 90 degrees, while the limestone dips eastward at 43 degrees.

Upper Medina forms the crest of Dickey's mountain. That ridge is cut by Big Spring run and the fragment north from

that gap is known as Lowrie's knob. The Medina of the knob ends abruptly at not more than 75 rods south from Spring Valley run; but it begins again at little more than 125 rods north from the stream.

Portage flags are in the road at the mouth of Spring Valley run. The lane leaving the road there soon reaches the variegated shales and comes to the ridge of the *lower conglomerate* just east from Cove creek. The ridge of the *upper conglomerate* appears beyond John Glenn's house. Jacob Glenn, living nearly a mile west from Cove creek, has done some prospecting for iron ore in the Pocono, resulting in the discovery of *micaceous ore*, such as that found at the Gordon place further south. The outcrop of the Pocono is deeply notched at the gap by which Roaring run issues from the Meadow Ground.

The ridge of the *upper conglomerate* is cut by Roaring run near A. Washabaugh's house, while Portage flags are exposed in part near J. T. Myer's house at the mouth of the run. The Hamilton beds are fairly well shown at W. Kendall's house, where they contain sheets of limestone and some *iron ore*. The lane turns southward at Kendall's house and soon reaches Medina at the top of the hill. Here the ridge of almost vertical Medina marking the course of the Cove fault is more prominent than at any point between this and the Bedford and Chambersburg pike. It becomes very insignificant between this lane and Cove creek, but it develops again immediately north from that creek and thence northward is perfectly distinct.

Following the lane from Kendall's, one comes to the Lower Silurian limestone within 10 or 15 rods after passing the summit of the hill. These rocks are quarried and their dip is eastward at from 30 to 35 degrees. The easterly dip prevails to the main road, which is reached opposite the lane leading to the United Presbyterian Church. An exposure near the road, but 100 rods north from the lane, shows the easterly dip. This dip near the fault prevails southward to Webster Mills, but it reaches not much further north than to this lane. The synclinal is very near where

the lane reaches the main road, for, at less than half a mile north the dip is 55 degrees westward.

The Medina ridge passes through Mrs. Alexander's property north from Cove creek and thence northward it is just east from the lane which follows Back run to the road leading from Comerer's mill to Meadow Ground mountain. As the ridge approaches that road, it evidently catches some Clinton, so that on the farms of J. Tritle and J. Fryman, an *iron ore* holding the place of the *block*, occurs plentifully. This continues for fully half a mile north from the late residence of J. Tritle, now occupied by Mr. Kendall. The ore is plentiful, but as far as can be determined from the fragments scattered over the surface, its quality is extremely variable and most of it is too silicious to be of any use.

The fault cuts across the strike of the beds, for, on the Tritle farm, the Medina wall has as its western foot the upper part of the Portage flags, so that on the opposite side of Back run, the top of the flags is reached and the yellow shales are shown in the road. The *lower conglomerate* makes a ridge, which is crossed at the second bend of the road, while the *upper conglomerate* is reached at the crook in the road and the base of the Pocono is near the northward bend beyond J. Woodall's house—its exact line being indeterminable owing to the great amount of débris.

Returning on this road to the McConnellsburg road, one passes the Medina ridge at the School-house and, within two or three rods, comes to the limestone dipping westward. A very ferruginous streak occurs immediately east from the School-house. The westerly dip prevails to the McConnellsburg road, where an exposure shows 55 degrees. This rate continues to McConnellsburg. For the most part, the limestones shown along the road are silicious. Much honey-combed chert occurs, and, in some places, the deep reddening of the soil proves the presence of not a little iron.

Returning now to Webster Mills and crossing Spring Valley run, one is on the Lower Silurian limestone, still dipping eastward, but at not more than 20 to 25 degrees. The sandstone ridge becomes bolder southward, until within half a mile it culminates in Lowrie's Knob. The synclinal in the

limestone is very near the first fork south from Webster Mills. One comes to the old Hanover iron mines at Sargent's Rocks, a low ledge which has been cut in making the road. These mines were worked for nearly 25 years to supply the Hanover Iron Works, but operations ceased in 1847, and now everything is concealed by rubbish, all the trenches being filled up. The trenches and strippings are extensive and the annual yield of the mines is said to have varied from 1,200 to 2,000 tons; but the deposit is believed to contain much ore still. This ore is a compact *brown hematite* and belongs to the upper part of Formation II. Samples were taken, which were sent to Mr. A. S. McCreath for analysis. He gives the following as the composition:

Ore of No. II from Hanover mines.

Metallic iron,	46.100
Sulphur,	0.115
Phosphorus,	0.083
Silicious matter,	21.500

Ore was obtained at one time from the Marcellus on the west side of Lowrie's knob, but the quality appears to have been somewhat inferior and the mine was abandoned. There is no reason why the ore should not be good, as it is at nearly the same horizon with the Ahl ore of Dublin township.

Immediately south from the ore mines, the limit of the limestone begins to recede from the Medina cliff, and at Big Spring run the bottom of the Utica shale lies very near the fork of the road and the limestone dips almost southwest at 20 degrees.

Descending Big Spring run, one sees the Utica and the Hudson, succeeded by the Lower Medina, which is imperfectly exposed. The Upper Medina forms a cliff dipping 60 to 80 degrees eastward and continuing along the road for upwards of 120 feet. The whole interval occupied by these groups is about 120 rods and the average dip is not far from 75 degrees.

Returning to the Cove road and going southward, one finds few exposures. The area of limestone grows narrower,

so that, at one third of a mile from the township line, the Utica shales are reached in Esther's run on J. Hendershot's farm. On J. Hege's farm, two thirds of a mile further north, the limestone reaches to barely west from the run, while it disappears eastward on a tributary stream below A. McCucas' house. It reaches J. Richard's farm on Jordan creek, which enters Esther's run at Carbaugh's School-house, while on the next tributary northward the width of the limestone area has increased to almost a mile. Details are obtainable only with difficulty, as the coat of Medina debris is so thick that the streams rarely afford any exposures.

Esther's run sinks within 50 rods east from this road at about the same distance from the Big Spring, so that perhaps the latter is but the continuation of Esther's run.

A lane leads eastward from the Big Spring. This affords few exposures for nearly 100 rods, but an anticlinal is shown at a few rods east from the lane leading to a house indicated on the county map as belonging to the Clarkson heirs. No good exposure was found to indicate the rate of dip, but at the next bend in the road it is very nearly 23 degrees eastward. A good exposure was seen at a quarry belonging to J. Sowers, Sr. near the first fork in the road, where the dip is nearly south-east at 16 degrees. The limestone is light blue and is burned for agricultural use. Samples have been analyzed by Mr. A. S. McCreath with the following result:

J. Sowers, Sr., limestone from No. II.

Carbonate of lime,	76.964
Carbonate of magnesia,	19.327
Oxide of iron and alumina,	0.840
Sulphur,	0.140
Phosphorus,	0.005
Silicious matter,	2.820

The limestone goes under just before H. Swisher's house is reached, where it has an easterly dip of 25 degrees. The Utica shales are shown at Swisher's, but they give place gradually to the Hudson yellow shales, which continue to the county road at W. Cuff's house. The Medina terrace is reached on this mountain road at a few rods beyond G.

Dark's house. This terrace is distinct in the southern part of the cove along both Dickey's and Tuscarora mountains.

No exposures were found northward from Cuff's for nearly a mile, but, just before the next fork in the road is reached, a lane turns off leading to D. Butterbaugh's house. Meanwhile the outcrop of the Utica shales has been pushed further east, so that now the limestone lies east from the road and is quarried for agricultural use by Mr. Butterbaugh.

The cover of Medina débris is deep between this and Spring Valley run, so that no exposures occur; but G. Dorty has opened the limestone on a branch of the run east from the road and another quarry was seen still further east on the north fork of the same run. The eastward dip continues along this stream to within 120 rods of the Cove Creek road and the axis of the anticlinal passes very near to F. W. McNaughton's house. Honeycombed chert is scattered abundantly over the surface to beyond A. W. Johnston's house, near which for a little way the soil is deeply stained with oxide of iron.

Still going northward on the eastern road, one finds no exposure in detail, but soon after leaving Spring Valley run, the Utica outcrop gradually moves eastward, so that at the Bedford and Chambersburg pike it reaches to the sharp northward bend by P. Finiff's house. Many years ago, some *ore* was mined on the Patterson farm for the Hanover iron works and the quantity appeared to be important. Explorations were made also on the Nelson farm; but the digging was given up nearly 40 years ago and all traces of explorations have practically disappeared, so that now no detailed information can be obtained. No satisfactory exposures were found along Kendall's run, but the axis of the Cove anticlinal seems to pass very near W. A. Kendall's house.

A road leading across the Meadow Ground and Scrub Ridge mountains leaves the Bedford and Chambersburg pike at barely a mile west from McConnellsburg. This road reaches the Medina which marks the course of the Cove fault, almost at once after leaving the pike and crosses the fault at Thomas' foundry. The Chemung yellow shales are here

in contact with the Medina. The *lower conglomerate* is feebly represented, as its fragments are mingled with those of the Medina ; but the ridge of the *upper conglomerate* is distinct between the houses of J. Lynch and W. Ross. The Catskill is reached before one comes to Back run ; but the road following that run quickly enters the Chemung and reaches the *upper conglomerate* at about 70 rods above Stouteagle's mill where it crosses the run. The conglomerate is shown half way up the hill where its dip is inverted, being eastward at 60 degrees. The proportion of conglomerate is small but the rock is very hard throughout. Red, gray and some olive shales are shown on the ridge and the line of fault is reached in a little hollow about 100 rods west from J. S. Pittman's house. Only a small strip of Medina is caught here, the whole area covered by fragments of that rock being barely 10 rods wide. Hudson shales are shown east from this and continue to the angle in the road, where all exposures cease.

Returning to the road leading to Meadow Ground mountain and there turning toward the mountain, one rides on Catskill certainly to 200 rods beyond the southward bend in the road ; but Pocono débris is present in such quantity that the top of the group can be determined only by the terrace, which it forms along the mountain side. At some poor exposures of Pocono near the summit of Meadow Ground mountain, the dip is westward at 28 degrees and the rock is cross-bedded.

The widening of the Scrub Ridge synclinal northward from Souder's gap in Scrub ridge is very rapid, so that where this road crosses, the outcrops of Pocono are separated by more than a mile and the trough holds some Mauch Chunk in the ill-drained area known as the "Meadow Ground." Erosion by Roaring run has formed a shallow valley and divided the mountain. The eastern division is known as Meadow Ground while the western division, unbroken by any but wind gaps from the Bedford pike to its termination in Thompson township, is known as Big Scrub Ridge or Licking creek mountain.

No exposures were observed in descending from Meadow

Ground mountain until beyond Roaring run, but the rounded hillocks prove that Mauch Chunk exists on the east side of the valley. The shales of that group are shown beyond the run at E. Brumbaugh's house and the Pocono of Scrub ridge is reached at 10 rods further. Some *brown hematite* in loose fragments was seen near Brumbaugh's house and the Mauch Chunk limestone occurs on this side of the valley, where it has been burned for agricultural purposes.

No good exposure of Pocono was found in ascending Scrub Ridge until the summit was reached, where the road passes through a shallow cut in an upper bed of that group. The rock is conglomerate and dips eastwardly at 20 or 23 degrees.

The Bedford and Chambersburg pike is the boundary line between Ayr township and

Todd township.

Exposures east from McConnellsburg on the pike are not very satisfactory. The limestone continues to beyond the "back" road, that leading southward along the east side of the cove, but the limit between the limestone and the Utica shale is indistinct. In like manner the line between the Hudson shales and the terrace of IV is ill-defined, but it passes not far from Mr. G. Finiff's house, for the Hudson shales are shown at but a little way west from that house. The Hudson yellow shales are shown near P. Finiff's house and the Utica shales are imperfectly exposed at a little way further west. The limestone is quarried within the limits of McConnellsburg borough, where a sample was obtained from Mr. Greathead's quarry. This was analyzed by A. S. McCreath, who gives the following as its composition :

Mr. Greathead's limestone from Formation II.

Carbonate of lime,	51.143
Carbonate of magnesia,	39.301
Oxide of iron and alumina,	0.660
Sulphur,	0.207
Phosphorus,	0.003
Silicious matter,	9.040

Exposures are indefinite in the borough, but the Cove anticlinal passes through it, for an easterly dip of 35 degrees was seen on the "back" road just beyond the borough line.

Mr. J. B. Hoke quarries and burns the limestone on the pike just east from the borough, where the dip is westward at 30 degrees. The rate of dip increases westward, being nearly 40 degrees at Dr. Trout's house.

No further exposures were found along the pike until the Medina was reached. The "wall" is dipping eastward but the exposure does not give a good idea of the rate. The rock has been passed before one comes to the toll-gate, where yellow shales are shown belonging between the *Chemung conglomerates*. There is much difficulty here in fixing the place of the *upper conglomerate*, as the slope is continuous to the Medina of the fault, and débris from the two coarse rocks is mingled on the surface. But the higher rock must pass very near the School-house, for the Catskill is reached at not many rods beyond. The beds of that group dip toward the fault. Catskill continues to the township line, beyond which one comes at once to the Pocono of Scrub ridge, which crosses the pike and soon runs out northward.

The Hustontown road leaves the pike at about half a mile west from the borough line. The limestone is quarried on this road at J. Jackson's place, somewhat more than 100 rods north from the pike, but the exposure is very poor. Occasional and very fragmental exposures of the Hudson shales were seen north from D. Rank's house as the road climbs Little Scrub ridge and, at the northward bend in the road, the Medina cliff is not more than 10 rods from the road. Some Lower Medina is here, for blocks with pitted surface are mingled with débris of white Medina. The Medina wall is crossed at the summit, where its dip is not well shown, but it is not far from 70 degrees eastward.

The western side of this fault is at the crest of the ridge and immediately beyond it one comes to yellow Chemung shales. Thence, no exposures occur until one comes to the church, beyond which are red and yellow shales and hard red sandstones belonging under the *upper conglomerate*.

That rock is reached before one comes to the run at Gress' saw-mill.

This Medina wall can be followed by the eye to the Knobsville gap and thence northward for nearly two miles, where the fault leaves Little Scrub ridge and thenceforward lies in Dublin township.

The Portage flags at the mouth of the Knobsville gap are dipping toward the fault, the dip being inverted. The Medina is in the gap, both white and red being shown, but evidently only a small part of each, as the whole exposure continues for barely 500 feet horizontally. The dip is almost vertical. The Hudson shales are imperfectly shown below the bridge and the Utica black shales are partially exposed in the road at the Reformed Church. These shales are almost vertical at an exposure further east, but the dip may not be true.

The limestone is reached at a little way west from the cross-roads and thence continues eastward to near the west edge of T. Cessna's farm. The Hudson shales are exposed on J. Spanuth's place and partial exposures of these continue as the road ascends Cove mountain, until the northward bend has been reached. There one comes to the "terrace." Thence few exposures were found until at the crest of Cove mountain, the white Medina is shown with eastward dip of 43 to 45 degrees.

Here one descends into Allen's valley and reaches the Clinton at the end of the long grade, where the direction of the road changes from south to north. The eastern boundary of this narrow valley is Tuscarora mountain, a monoclinical with westerly dip, composed of Medina like Cove mountain with which it unites at somewhat more than a mile north from the Bedford and Chambersburg pike. Little Aughwick creek flows through this valley having its source very near the "locking" of the two mountains. Just beyond Tuscarora mountain is Path valley in Franklin county whose geological structure is similar to that of McConnell's cove.

Few exposures occur in Allen's valley. Within Todd township, little clearing has been done and everything is

concealed by the forest. The Medina of Tuscarora mountain is reached at Cowan's gap, through which the road leads to Path valley. The dip is 60 degrees. Beyond this some exposures were seen of Clinton yellow, green and drab shales, but nothing is shown in detail. Near the northern line of Todd township, a coarse, hard fossil ore is shown in considerable quantity. As this has been the cause of great expectations, samples were taken for analysis. Mr. McCreath gives the composition as follows :

Hard fossil ore from Allen's valley.

Metallic iron,	18.725
Sulphur,	0.020
Phosphorus,	0.067
Silicious matter,	69.060

This material is certainly abundant, but the analysis shows it to be utterly worthless. So that there is no need of expending time or money upon explorations.

Dublin township.

Entering this township from the west at Clear Ridge post-office, one finds himself on the variegated shales underlying the *Chemung upper conglomerate*. The *lower conglomerate* forms a low ridge which is crossed by the road beyond J. Holland's house and there the yellow shales are reached. The Portage flags are brought up as the road approaches a little run east from B. F. Myers' house and continue to where the road crosses a tributary to Plum run, on which they become massive. There, exposures cease and Plum run clearly flows in a valley eroded amid Hamilton shales.

Oriskany is reached at the crest of Plum Run ridge, which is a distinct topographical feature. The rock is not exposed in place along the road, but it forms a comb at one third of a mile south, which is easily seen from beyond Fort Littleton. Lower Helderberg is ill-shown along the road but its shaly beds are exposed occasionally. The red beds at the top of the Clinton are reached at the crest of a little ridge barely 100 rods from Fort Littleton, and the red rock marking the summit of the group shows the features which characterize it in Bedford county, except that the hard beds

are extremely thin. Some streaks of limestone underlie the red and yellow shales, beyond which one comes to the valley of Little Aughwick creek.

Turning northward at Fort Littleton and taking the Orbisonia road, one follows the west foot of Black Log mountain, a bold Medina ridge marking the west slope of the Black Log anticlinal, as Shade mountain marks the east side. These ridges unite at less than a mile north-east from Fort Littleton. The Orbisonia road lies in the Clinton to the county line. The highest beds of the group are shown at a little way north from Dyson Fraker's house. The dip of the Clinton beds varies little from 35 degrees north-westward. *Fossil* ore of very fair quality occurs in fragments on the side of Black Log mountain, but no attempt has been made to ascertain the quantity.

The Lower Helderberg limestone is quarried somewhat extensively on Ephraim Ramsay's farm, one third of a mile north from Fort Littleton. Samples were taken from this quarry, which were analyzed by Mr. A. S. McCreath, who gives the following as the composition:

Limestone of No. VI from Ephraim Ramsay's farm.

Carbonate of lime,	91.303
Carbonate of magnesia,	2.043
Oxide of iron and alumina,	0.810
Sulphur,	0.201
Phosphorus,	0.004
Silicious matter,	5.550

Sulphate of baryta occurs in the Lower Helderberg on Dyson Fraker's farm near the creek, where it was mined somewhat extensively for a year or more. But the mineral, which was used exclusively in the adulteration of white lead paints, contains some iron, which rendered it worthless; the work was abandoned more than a year ago.

The Oriskany ridge lies west from Little Aughwick creek to the county line.

Returning to Fort Littleton and going eastward, one comes to the Lower Helderberg at W. F. Trout's house and the road remains in that group to A. Anderson's house. Some petty wrinkles in the shales of this group carry its

limits well westward. The eastward dip sometimes becomes 60 degrees while in some of the wrinkles the westward dip is vertical. Oriskany is reached at A. Anderson's house, where it makes a bold ridge, which is cut by Little Aughwick creek at barely one third of a mile further north. The sandstone is partially exposed in the roadside at Mr. Anderson's house, where the total thickness seems to be little more than 50 feet. Thence one is in the Hamilton to N. L. Cline's house.

The bottom of the Chemung is reached at N. L. Cline's house where a hard sandstone is shown dipping eastward at 30 degrees. The Portage flags and shales are shown further up the road and are succeeded by yellow shales, which continue to about 110 or 120 rods from the crossing of Nine-Mile run, where one comes to the *lower conglomerate* of the Chemung. The dip increases eastward to 45 degrees and at last it passes the vertical as one approaches the Cove fault, where at once the Hamilton is reached, with yellow and gray or ashen shales. The black shales are shown directly beyond the fork leading to Nine-Mile Run gap through Little Scrub ridge. There the Oriskany of the Cove anticlinal is at barely 30 rods from the Old State road. The Marcellus shale dips westward at 50 degrees.

D. Ahl has made some prospecting pits here very near the bottom of the Marcellus drab shales and has obtained much *brown hematite* ore, of which samples were taken for analysis. Mr. McCreath gives the following as the composition:

D. Ahl's Marcellus ore.

Metallic iron,	46.475
Sulphur,	0.082
Phosphorus,	0.032
Silicious matter,	17.470

which shows this to be an ore of decided excellence.

The Oriskany is crossed by the road before L. Dubbs' house is reached and it makes a distinct ridge with the sandstone standing out as a comb at a little way south-west from the house. It passes into Huntingdon county very near the Shade Gap road. Lower Helderberg is exposed in the road
20 T^a.

before one comes to the school-house, but its base is not shown well. The higher limestones are quarried and burned on the property of the Kelly heirs, on the north side of Little Aughwick near the Shade Gap road.

On the Shade mountain side of the valley the Clinton follows the mountain side and fragments of *fossil* ore are abundant. Ore of moderately good quality was seen on P. Kerlin's farm nearly a mile from Fort Littleton, and ore of the same kind has been picked up at localities further north. But no explorations have been made to ascertain whether or not the ore is present in quantity. Lower Helderberg limestone is quarried very near the county line, while the Marcellus shales on the east side of the Oriskany ridge contain some *brown hematite* ore; but the quantity is unknown.

South from Burnt Cabins, J. Kelly and D. Fore did some prospecting for *Clinton ore* near the northern termination of Little Scrub ridge. The pits on the Kelly property are about 20 feet apart and 12 feet deep. Sandy *brown hematite* was found in these, which closely resembles that seen near the Hanover Iron Works. The same ore was reached on the Fore property. Fossil ore seems to be wanting on Little Scrub ridge.

The Medina of Little Scrub ridge goes under at a few rods east from the crossing of Little Aughwick creek, but does not touch the creek. Just west from the fork of the road the dip of the Clinton is 45 degrees N. 30° W., while immediately east from that fork the dip is 60 to 70 degrees in the same direction. On the State road, a synclinal was found before reaching the county line, which holds Lower Helderberg in Huntingdon county, but that group does not appear to reach into Fulton.

Turning into Allen's valley at Burnt Cabins, one finds the green Clinton shales dipping eastward at 35 degrees, as he ascends the hill south from M. Boyle's house. Two prospecting pits were seen at the hilltop, but they do not seem to have reached the ore. Thence to the township line there are practically no exposures, the valley being almost wholly uncleared. The two ridges, Cove and Tuscarora, approach

rapidly so that at the township line Allen's valley is hardly half so wide as at the county line.

Going southward from Fort Littleton on the road leading to Knobsville, one comes to the Clinton red rocks at the fork, where one leaves the old State road. The Lower Helderberg limestone is exposed at a little way beyond and shows dip increasing from 35 to 65, but decreasing quickly to 15 degrees as the sharp southward angle in the road is approached. There the road passes through the Oriskany ridge. The limestone is quarried alongside of the road. The Oriskany ridge is very well marked here and it lies at a little way west from the bend in the road, until about 80 rods beyond H. Wilson's house, where the road crosses a little run and turns almost south. The ridge lies near to R. McFarland's house.

The Marcellus black shales are shown in the east bank of the little run and somewhat imperfectly in the road, but the exposures continue for but a short distance. The Portage beds are wholly concealed, but near the top of the ridge yellow shales are shown and one soon comes to the *lower conglomerate* of the Chemung. The Scrub Ridge synclinal is crossed at a little way from S. Kerlin's house. The westward dip is quite gentle until near the first fork in the road, where it becomes north-west at 85 degrees. There exposures cease and the surface is coated with Medina débris; but nearer Knobsville gap, by which Licking creek passes through Little Scrub ridge, yellow shales succeeded by the Portage flags are shown with inverted dip. The former are dipping eastward at 60 degrees, but the rate increases so that at the last exposure the flags have a dip of nearly 85 degrees. At the township line, the Medina sandstone is reached and it is poorly exposed in the gap.

Returning to the State road and going southward on it, one comes to Lower Helderberg very near J. Buckley's house, but exposures are strangely indistinct, so that the line between Lower Helderberg and Clinton cannot be fixed within 300 feet. One comes quickly to the massive beds of the Lower Helderberg, one of which is quarried by Mrs. Benedict as well as by B. Woolet and J. Grider near the

road. The dip of the limestone is flexuous. The Oriskany ridge is crossed immediately beyond J. Grider's house. An important deposit of *brown hematite* occurs in the Lower Helderberg very near the top of the group and it is fairly well exposed at the road side by Mr. Grider's house. This deposit is certainly continuous on both sides of the Lower Helderberg valley, for large blocks of it were seen along the State road and in the fields along the foot of the other ridge. The ore is variable in quality, some of it being merely a breccia, while much of it very good. Its place is very near the transition bed at the top of the Lower Helderberg or bottom of the Oriskany.

The Hamilton is imperfectly exposed in the road west from J. Grider's house. Fragments of *brown hematite* occur here but whether they belong to the Marcellus or have rolled down from the Lower Helderberg could not be determined. The Hamilton continues to about 115 rods west from the Grider house. It does not extend southward to Licking creek. The Oriskany ridges unite at about 200 rods south-west from the Old State road.

The *lower conglomerate* of the Chemung is reached on the State road very near D. F. Chestnut's house. The dip is comparatively gentle, not more than 20 degrees, to beyond the stream crossing at J. Chestnut's house. Thence the rate increases gradually until it becomes 45 degrees before one comes to Hustontown, where the upper conglomerate is exposed.

CHAPTER XIV.

The Coal Interests.

The coal area within this district is limited, occupying less than one third of Wells township in Fulton county and two thirds of Broad Top township in Bedford county, as shown by the coloring on the map. Even of this, not all is available. For along the whole length of the Broad Top anticlinal the Pottsville conglomerate is at the surface and on each side of the Pottsville space, the covering of the *coal* is so thin as to destroy the value; while around the whole field is a strip of barren area, either without *coal* or with the cover too thin.

The structure of the region presents obstacles to mining which are very serious. On Sandy run in the second basin, the energetic folding of the beds along the east side of the Grey's Run anticlinal has crushed the coal to such an extent as to render it worthless economically, while in the Cunard basin on the same run, a large part of the workable coal on the west side has been rendered worthless by the same agency. A similar difficulty has been encountered in the first basin and to a moderate extent in other basins on Six-Mile run.

Irregularity of the folds produces further complications, interfering with the drainage and compelling a zigzag course in the gangways. Abrupt though short rolls are common, perplexing faults occur, such as have been found in the old workings at Mt. Equity and in the headings of the Cunard shaft; horse-backs or rolls of the roof are sometimes of great extent, and the coal is more or less crushed and twisted in their neighborhood. The beds themselves show

great variations in thickness and serious variations in the quality of their coal.

Notwithstanding these difficulties, which would almost destroy the value of the property in the eyes of one accustomed only to the regular and gently dipping coals of western Pennsylvania, the beds of the Broad Top coal field have great economical importance, not only because of their proximity to market, but also of the decided excellence of the coal obtained from any of the mines.

The important beds are the *Kelly* and the *Barnet*. The *Cook* has been mined to a slight extent in one of the basins, but, for the most part, the variations in thickness and quality of its coal are too great to permit profitable mining.

The *Kelly coal bed* is worked in the first and third basins of Six-Mile run, and mines have been operated in this bed in the fourth, fifth, sixth, seventh and ninth basins. It is mined in the fifth basin on Sandy run and it has been mined in the second. It has been opened on the waters of Long run in the fifth, sixth and seventh, but no mining was doing at the time the area was examined.

On Six-Mile, this bed shows a thickness of 4 feet in the first basin and the thickness is maintained with great regularity, except where a roll in the roof reduces it. The coal is much esteemed as fuel for steam purposes but especially for the manufacture of coke. The quality of the coal is poorer in the other basins along this run. It is a fair shipping coal in the Duval or third basin, but thence eastward it is so poor that it cannot be sold; at least such is reported to be the experience of those who have mined it. The crushing in the second basin on Sandy has destroyed the market value of the coal, but in the fifth or Cunard basin, the quality is satisfactory and extensive mining operations are carried on. The following analyses show the character of the coal at different localities:

1. Mt. Equity mine, 1st basin on Six-Mile.
2. R. B. Wigton's mine, 5th basin on Six-Mile.
3. Cambria mine, 5th basin on Sandy run.

Water,	0.435	0.610	0.575
Vol. combust. matter,	19.245	20.375	16.515
Fixed carbon,	73.865	67.497	76.720
Sulphur,	1.039	3.583	1.230
Ash,	5.416	7.935	4.960

The analyses are by A. S. McCreath.

The coal from the Mt. Equity mine yields a very superior coke, which is used by the Kemble Coal and Iron Company in their furnaces at Riddlesburg. No attempt has been made to manufacture coke at any other mine, but a sample of pit coke was obtained from the Cambria mine on Sandy, which was made from slack alone and so fails to give a just impression respecting the character of coke such as would be made from "run of mine" coal. An analysis of Connellsville coke, also by Mr. McCreath, is given for comparison :

1. Coke from Mt. Equity works, Six-Mile run.
2. Pit-coke from Cambria mine, Sandy run.
3. Coke from H. C. Frick's works near Connellsville.

Water,	0.095	1.015	0.000
Vol. combust. matter,	0.575	2.297	0.000
Fixed carbon,	89.083	86.782	87.259
Sulphur,	0.925	1.928	0.746
Ash,	9.322	7.978	11.995

Though these Broad Top cokes are inferior to the Connellsville in respect to sulphur, yet they are superior to it in point of ash. The coke is hard and bears well the burden of the furnaces at Riddlesburg.

The *Barnet coal bed* is mined in the fifth, sixth and seventh basins on Six-Mile as well as on the southern side of Broad Top mountain in Fulton county. It shows noteworthy variations in thickness which detract materially from its value. The coal is good in the first basin on Six-Mile run but the variations in thickness render it unavailable. Further east it cannot be reached without deep shafting until the fifth basin, where it is mined in the Cunard shaft, but is at the creek level on the opposite side of the valley. Thence to beyond North Point the openings are numerous. The workable coal in the fifth basin varies little from 3 feet 8 inches and is in two benches ; but in the basins further

east, only one bench is found and the workable coal varies from 2 feet to 2 feet 6 inches. The bed is thicker in Fulton county. Two analyses by Mr. A. S. McCreath show the character:

1. Cunard shaft, Six-Mile run, Bedford county
2. Wishart's mine, Wells Valley township, Fulton county.

Water,	0.570	0.635
Volatile combustible matter,	18.015	16.220
Fixed carbon,	78.078	78.844
Sulphur,	0.892	0.826
Ash,	2.445	3.475

The coal is thought to be admirable as a steam coal and that from the Cunard shaft is shipped to tidewater to be used by steamers.

CHAPTER XV.

The Iron Interests of the District.

The Furnaces.

The earliest attempt to manufacture iron within this district was made by Messrs. Lane & Davis in 1802, when they built Hopewell furnace on the Juniata river opposite the mouth of Yellow creek. It was supplied with ore from the base of the Mauch Chunk, and some ore was obtained from the Lower Helderberg of Warrior ridge. The furnace was run with more or less success until 1830 or 1831, when the stack was rebuilt by Mr. Lesley. It has been in blast almost constantly since that time. The present owners are Messrs. Lowry, Eichelbarger & Co., and the ores are obtained from the Clinton and Lower Helderberg near Everett in West Providence township. The statistics of the furnace are

Height of stack,	31 '
Diameter at boshes,	8 '
Diameter at tunnel-head,	2½'
Pressure of blast,	1½ lbs.
Temperature of blast,	850
Fuel,	charcoal.

The burden is:

Charcoal,	460 lbs.
Ore,	1000 lbs.
Limestone, 50 to 60 per cent. of the ore.	

Six charges yield one ton of metal and the daily yield is about five tons. The mixture employed is, brown hematite, *four fifths*; fossil ore, *one fifth*. In former times, when the furnace was run with cold blast, the daily yield was not far from 15 tons per week.

Mr. J. W. Swank says that in 1806, Mr. Lane built Lemnos
(313 T².)

forge on Yellow creek at two miles from Hopewell. With it a slitting-mill was erected. But these works have been abandoned for many years. Bedford forge was built either in 1812 or 1816 on the same creek by Messrs. King & Swope. Hanover forge was built during 1822 in Fulton county, 9 miles south from McConnellsburg, by John Doyle, and Hanover furnace was built at the same place in 1827 by John Irvine. The furnace was rebuilt in 1844 by John Pott, who kept it in blast until 1847, when, like so many other furnaces at a distance from convenient transportation, it went out of blast finally. Mr. James Pott gives the following as the dimensions of the new stack :

Height,	30'
Diameter at the boshes,	6½'
Diameter at tunnel-head,	2½'

The structure is substantial and, though abandoned for 35 years, it could be put in blast with but slight cost. The blast was cold and the product not far from 25 tons per week. The ore was obtained from the Hanover mines in the limestone of No. II on the east side of Lowrie's knob. Trials of Clinton and Marcellus ores were made but they appear to have proved unsatisfactory.

Elizabeth furnace was built near Woodberry in Morrison's cove in 1827 by Messrs. King, Swope & Co., Dr. Shoenberger being the company. The ore was obtained from the surrounding country and belonged to the Calciferous. After running nearly 20 years, the stack was torn down and removed to Bloomfield near the line of Blair county, where an important deposit of wash ore had been discovered. At a somewhat later date, the stack was again taken down and was removed into Blair county, where it was rebuilt as Rodman furnace. The weekly product at Bloomfield was not far from 50 tons.

The furnaces of the Kemble Coal and Iron Company are at Riddlesburg on the Juniata river. They were begun in 1868 and filled for the first time on July 1, 1869. With the exception of short intervals, they have been in constant operation. The statistics as given by Mr. Kelly, the superintendent, are :

	I.	II.
Height,	60'	60'
Diameter at boshes,	14' 10"	15'
Diameter at tunnel-head,	8' 3"	8' 6"
Number of tuyeres,	4	6
Pressure at engines,	6 to 7 lbs.	
Pressure at stack,	3 lbs.	
Temperature of blast,	880	

The blast is heated by 4 Thayer stoves. The charge is:

Coke,	2400 lbs.
Ore,	2500 to 3200 lbs.
Limestone, 50 to 75 per cent. of the ore.	

The ores used are altogether *fossil*, but these contain no inconsiderable admixture of *brown hematite*. They are obtained from Dutch Corner and Wolfsburg in Bedford township, Everett and Tatesville in West Providence, and the Cambria mine in Hopewell township. The variations of ore and limestone in the charge are due to the varying proportions of silica in the ore. Two charges give one ton of metal. The quantity of coke per ton varies from 2.6 to 2.8 tons and that of limestone from 1.5 to 1.8 tons. The mixture of ores used in making the irons, of which analyses are given beyond, are:

Dutch Corner,	one fourth
Tatesville,	one half
Everett,	one eighth
Wolfsburg,	one eighth

Analyses of these ores are given beyond.

Only one of the furnaces was in operation at the time of visit as the other was undergoing repairs. The daily yield of the single furnace was from 36 to 38 tons. The fuel is supplied by 80 bee-hive coke ovens and the coal is obtained from the Mount Equity coal mine on Six-Mile run.

Mr. Robert Hare Powell is erecting a large furnace on the Juniata near Saxton. The writer has been unable to obtain the statistics.

The Iron ores.

Iron ore occurs to a greater or less extent in all the groups exposed within the district, so that loose lumps are found on farms everywhere, often leading the farmers to entertain false hopes of future wealth.

Coal Measures ores.

No ore of economic importance was discovered in the Coal Measures, but, at many localities, a very considerable deposit of clay iron-stone is present under the *Barnet coal bed*. This bears much resemblance to the "Blue Lump" of Fayette county. No explorations of this ore have been made, but it certainly deserves examination.

Mauch Chunk ore.

Brown hematite occurs in the Mauch Chunk within a few feet of the bottom of the group. It was seen in Hopewell township opposite Hopewell; at Hopewell and at several places in Ground Hog valley of Broad Top township. In Fulton county, it is present at the foot of the Pocono ridges in Wells and Brush Creek townships and fragments of it were seen on the Meadow Ground in Ayr township. This ore has been mined only in Hopewell township and in Ground Hog valley of Broad Top township, both in Bedford county. The mining at the latter locality was extensive and some hundreds of tons were shipped to Johnstown to secure a thorough test. But the ore was condemned as too cold short. Mr. McCreath's analysis resulted as follows:

Metallic iron,	41.450
Sulphur,	0.026
Phosphorus,	1.257
Silicious matter,	16.340

The ore at other localities is accompanied by *manganese*, good specimens of that ore occurring in the valley of Oregon creek in Wells township of Fulton county. Nothing can be determined respecting the amount of ore at this horizon in Fulton county localities, as no attempt has been made to prospect them and the existence of the ore is indicated only by loose fragments scattered over the surface.

Pocono ores.

No deposits of economic importance have been found in the Pocono; but iron ore is present at several horizons and in such quantity, that when set free by decomposition of the rock, it seems to indicate the presence of a considerable

body. Nodules of *brown hematite* are scattered in great numbers throughout the topmost sandstone of the group; *brown hematite* and *pyrolusite* are present as nodules in the lower beds. The quantity, altogether, must be very great and the surface indications have led the county map makers to place patches of iron ore along the west side of Ray's hill in Bedford county and along both sides of Whip cove as well as along the east side of Sideling hill in Union, Bethel, Belfast, and Licking Creek townships of Fulton county. But the material is unavailable, as it does not occur in bodies.

Very fine *brown hematite* occurs at the lower horizon along the west side of Scrub ridge in Licking Creek township and *micaceous ore* has been obtained at the same horizon on the east side of the same ridge in Ayr township. But these are all unimportant as the cost of mining would exceed the market value of the product.

Chemung ores.

Small pots of *brown hematite* occur at many localities in the lower part of the Chemung series; and these have given rise to false estimates of the value of property at more places than one. Ore was seen in the hills west from Buffalo mountain; at a mile or so south-west from Saxton; and at many places in Monroe and Southampton townships of Bedford county. The ore appears to be of moderately good quality, but nothing definite can be learned respecting the quality, except that the scattered fragments do not indicate the existence of an extensive deposit at any locality examined.

Hamilton ores.

Nodules of ore occur throughout the Hamilton, but deposits of economic importance are confined to the Marcellus shales. The drab shales contain an apparently persistent deposit in Fulton county, which has been opened recently in Dublin township. Openings were made many years ago in Ayr township near Lowrie's knob and southward toward the Hanover Iron Works. Mr. Ahl's pits in Dublin town-

ship yield a very fair ore, but the southern pits seemed to contain only an inferior grade. Mr. Ahl's ore has the following composition:

Metallic iron,	46.475
Sulphur,	0.082
Phosphorus,	0.032
Silicious matter,	17.470

Ore occurs at the lower horizon along Warrior ridge south from the Juniata in Bedford county. Nothing is known, however, respecting the quantity as the pits were of insignificant size at best and now they are filled with rubbish. But there must be much in southern Monroe, for an extensive deposit of *bog-iron* ore was seen north from Cheneysville. Samples of *brown hematite* were obtained from the Barndollar & Baughman place, one mile south from Everett, which have the following composition:

Metallic iron,	53.050
Sulphur,	0.056
Phosphorus,	0.087
Silicious matter,	7.800

No attempts have been made to discover this ore further north along Warrior ridge. No traces of it were seen in the Bedford synclinal. It seems to be wanting in Fulton county.

Lower Helderberg ores.

Brown hematite occurs at many localities in the Lower Helderberg. It was mined at one time at two places on the west side of Warrior ridge in Hopewell township of Bedford county to supply the old furnaces and forges on Yellow creek; and, if one may judge from the extent of the excavations, the mining operations must have been important. Small quantities of the ore have been found along the ridge in West Providence, south from the river, as well as in Monroe township, where the quantity seems to be considerable. The only locality, at which mining is now carried on, is in West Providence township on the Juniata river, west from Everett. There the ore occurs in the decomposed shaly limestones belonging at the base of the group, whereas at the other localities it is found in the com-

pect limestones high up in the series. The peculiar occurrence of the ore at Lowry, Eichelbarger & Co.'s mines is described in the chapter on Black Valley. The ore is mined to supply Hopewell furnace, and its composition according to McCreath is :

Metallic iron,	42.650
Sulphur,	0.099
Phosphorus,	0.182
Silicious matter,	18.730

Iron ore occurs in the upper part of this group near Bedford and a large pocket was opened during the construction of a reservoir south from the borough ; but the ore is evidently sandy and of little value. The same one is present at many localities along the west foot of Wills mountain and it has been mined on the property of J. Wolford in Londonderry township north from Fossilville. Some ore has been shipped from this farm and it is said to be very good.

Iron ore occurs in the upper part of the Lower Helderberg in Dublin township of Fulton county and the quantity is undeniably very great. As at all other localities it is a *brown hematite*, but the quality is decidedly variable, and no opinion respecting the value of the deposit can be given until systematic exploration has been made.

The Clinton ores.

The Clinton is the important ore-bearing group of the district. Three ore beds were recognized :

The Fossil.

The Frankstown.

The Block.

Besides these, some thin indefinite seams occur in the highest parts of the group, but they have no economic value.

I. The Fossil ore bed.

This is the important bed, which is mined at Powel's Cove mines in Liberty township ; by the Kemble Coal and Iron Company at the Cambria mine in Hopewell township ; by

the same company and by Lowry. Eichelbarger & Co., in West Providence township north from the Juniata river; it has been well exposed south from that river by Scott and Russell in West Providence and at many localities in Monroe and Southampton townships by J. B. Williams. It has been prospected on the west side of Evitts mountain by Robert Hare Powel and E. F. Kerr, while the Kemble Company has had extensive mines along the same line but further north. On the east side of Wills and Dunnings mountains it has been mined extensively by the Kemble Company and it has been prospected to the Maryland line by E. F. Kerr and others. It has been prospected and mined on the west side of Wills mountain by John Cessna and by the Cumberland Coal and Iron Company. It is the main source of supply for the Kemble Coal and Iron Company's furnaces at Riddlesburg and from it must come the ore for Mr. Powel's new furnace at Saxton.

This bed has been proved to exist along the west side of Wills mountain from the Maryland line to beyond the Juniata river, and mining has been done in Londonderry, Harrison, and Napier townships. The bed is single in Londonderry and its thickness varies from 6 to 23 inches, with an average of 15 to 18 inches; but in Harrison the bed is double, showing two layers, 18 and 2 inches separated by 2 feet of sandstone. When thus double, the lower bed is usually known as the *Twin seam*. The ore is fine-grained with some specular ore. The following analyses by Mr. McCreath show the character of the ore:

- I. Fossil ore, Adam Wolford's farm, Londonderry.
- II. Fossil ore from Jacob Hardman's farm, Harrison.

Metallic iron,	45.225	49.875
Sulphur,	0.025	0 013
Phosphorus,	0.454	0 422
Insoluble residue,	21.620	13.890

In each case the samples had been exposed for a long time to the weather.

In considering these, as well as the other analyses of iron ore given in this chapter, one should remember that they represent the dried ore; but as the material comes from the

mine it will contain no inconsiderable percentage of water, whereby the relative percentage of iron will necessarily be less than that shown by the analysis.

The bed becomes more complex in structure in Napier township, the following being the section :

Ore,	0' 10"
Shale,	0' 6"
Sandstone,	2' 0'
Ore,	1' 6" to 0
Shale,	1' 3"
Ore,	0' 10"

The ore from the lowest bed is said to be the best.

All of these mines have been idle for several years, little work having been done on any of them since 1873. No other mining operations have been carried on along this side of the Wills-Dunning anticlinal, except in the neighborhood of Dutch Corner, where the features are the same with those observed on the east side of that anticlinal in Dutch Corner.

Many openings have been made between the Maryland line and the Juniata river along the east side of Wills-Dunning anticlinal, and systematic mining has been carried on by the Kemble Coal and Iron Company northward from the Juniata river. No exposures now remain south from the river. According to the best information attainable, the thickness of the bed does not average more than 14 to 16 inches in Cumberland Valley township, although it is said to be 23 inches at one locality and 3 feet at another. In Bedford township near the southern line, it is said to be but 14 inches. Only prospecting pits have been dugged south from the Pittsburgh pike and, in these the structure of the bed appears to have been found simple in all cases. But further north opposite Wolfsburg, the structure is complex as in Napier, the following being given as the section :

Ore,	0' 8" to 1' 2"
Shale,	0' 6" to 1' 0"
Blue sandstone,	2' 0" to 2' 6"
Ore,	0' 8" to 1' 6"
Shale,	1' 6"
Ore,	0' 4"

The main source of supply is the upper bed, which averages about 10 inches, while the middle bed is very uncertain, sometimes being wholly cut out by variation of the sandstone. The mines in Dutch Corner, the north-western part of Bedford township, have been operated for a number of years by the Kemble Coal and Iron Company. Two sections taken half a mile apart show these variations:

Ore,	2' 4"	3 0"
Shale,	4' 0"	3' 0"
Ore,	0' 9"	0' 4" to 2"
Shale,	0' 4"	1' 0"
Sandstone,	0' 11"	1' 6"
Ore,	1' 2"	0' 7"

Only the upper bed is mined. Near the outcrop where the ore was stripped soft ore was found, but after solid cover was reached the ore became hard almost at once. The available ore varies little from 2 feet.

The following analyses have been made by Mr. A. S. McCreath:

- I. County Farm, Bedford township.
- II. Kemble Company's mine, Wolfsburg.
- III. Kemble Company's mine, Dutch Corner—hard ore.

Metallic iron,	44.400	46.450	25.725
Sulphur,	0.017	0.011	0.034
Phosphorus,	0.161	0.344	0.251
Insoluble residue,	22.270	12.770	9.020
Carbonate of lime,	—	11.607	46.339
Carbonate of magnesia,	—	1.136	2.648

Prospecting pits have been sunk at several places along the west side of Evitts mountain to prove the presence of the fossil ore bed and mining operations were carried on extensively by the Kemble Company at the Juniata gap. But the mines have been abandoned and the prospecting pits have become full of rubbish, so that no sections can be obtained now. Mr. Franklin Platt's section in the Kemble Company's tunnel is as follows:

Ore,	1' 0" to 1' 5"
Sandstone,	1' 1" to 2' 6"
Ore,	0' 4" to 1' 4"
Sandstone,	2' 0" to 2' 4"
Ore,	0' 6" to 1' 8"

The ore obtained here is very good, but the shales cannot be separated easily, and the temptation to mix shale with ore appears too great to be resisted by the diggers. So the mines were abandoned.

The most important area of this fossil bed is Black valley, which lies between Tussey mountain and Warrior ridge. The ore has been proved by J. B. Williams from the Maryland line to West Providence; by Scott and Russel in West Providence south from Juniata; by Lowry, Eichelbarger & Company, the Kemble Coal and Iron Company, and Robert Hare Powel from the Juniata river to the line of Huntingdon county.

Ordinarily the bed is double in this area, the upper division being known as the *Fossil* and the lower as the *Twin*. The upper is usually the more important.

No mining has been done south from the Juniata, but the extensive prospecting pits belonging to J. B. Williams and Scott and Russell, show the character very well. The exposures in Southampton township give

Ore,	3' 0"	1' 6"	1' 1"
Clay,	0' 4"	0' 2"	0' 1"
Ore,	1' 3"	0' 10"	2' 3"

and at all of these the ore is very good. The lower bed is softer than the upper, the latter usually containing not a little of *brown hematite*.

The exposures in southern Monroe are not wholly satisfactory and the surface ore is somewhat inferior, showing many small amygdules of quartz, which, however, may disappear at an inconsiderable depth below the surface. Further north in this township, numerous pits have been sunk on the farm of John Pennel, Sr., on that of B. B. Steckman, as well as on several other farms. None of these shows the structure in detail. The ore changes in some of them from ordinary *fossil* to *brown hematite*. The thickness in some pits is almost 6 feet, but the ore is not compact and the pits probably have not passed beyond the broken outcrop. The ore is of very fair quality at all of these pits as appears from the analyses.

The Scott and Russell pits begin north from the Monroe

line and show some variation in structure. Three measurements give :

Ore,	3' 0"	1' 6"	0' 6" to 0' 8"
Shale,	0' 6"	3' 2"	0' 3"
Ore,	3' 0"	1' 2"	1' 5" to 1' 8"

A fourth measurement shows four divisions of the ore. Some *brown hematite* always occurs in the upper division, which, however, is often sandy. The following analyses by Mr. A. S. McCreath show the variations of the ore south from the Juniata river :

- I. Isaac Wilson's farm, Southampton township.
- II. William Barkilow's farm, Southampton township.
- III. John Pennel's farm, Monroe township, (*brown hematite*.)
- IV. B. B. Steckman's farm, Monroe township.
- V. & VI. Scott and Russell openings, West Providence township.

	I.	II.	III.	IV.	V.	VI.
Metallic iron, . . .	48.150	54.150	53.850	45.225	17.125	54.950
Sulphur,	0.022	0.022	0.025	0.022	0.017	0.019
Phosphorus,	0.298	0.232	0.723	0.175	0.161	0.318
Insoluble residue, .	13.810	7.790	3.770	22.610	69.130	9.600
Water,	—	—	12.534	—	—	—

With the exception of No. 6, these analyses are of specimens which had been exposed to the air for from two to five years. But the sample for No. 6 was a section of the bed taken from a pit newly digged. The sample of No. 5 was probably not a fair one ; but the pit contained so much water that the samples had to be taken from such material as lay on the surface.

The extensive mines of the Kemble Coal and Iron Company in West Providence and southern Hopewell extend for upwards of three miles along the bed and the tunnel reaches the ore at 325 feet below the outcrop. The bed shows the following section :

"Fossil,"	2' to 6'
Interval,	0' to 6'
"Twin,"	2' to 6'

Brown hematite and *fossil* ores occur together in the upper division, but the former is said to disappear gradually be-

yond 50 feet from the outcrop. A nest of calcareous ore was found at 325 feet below the outcrop, which led to the fear that the ore had changed its character; but the variation proved to be merely local and the ore now obtained, though somewhat silicious, is of very fair quality. The bed shows noteworthy variations in thickness, occasionally becoming very thin or almost disappearing, but again thickening to far beyond the average, there being one stretch of more than 1000 feet, in which the combined thickness of the two divisions is nearly 12 feet, while the parting has diminished to a mere knife-edge.

A long prospecting tunnel was driven to reach the ore at somewhat more than a mile south from Yellow Creek gap in Hopewell township. It is supposed to have reached the horizon of this bed, but instead of ore, only ochreous clay was found. Exploration was made along the line of this clay, but no ore was obtained and the enterprise was abandoned. This failure has given rise to the belief that the ore is wanting for some distance on the south side of the great gaps, or that, when not wanting, it is of decidedly inferior quality. This theory may be true or it may not be true; but one thing is very certain—the present state of knowledge affords no basis of facts for any such theory, so that the proposition is wholly gratuitous. Had the Batesville tunnel been driven further south so as to reach the ore-line in one of the “wants,” a similar generalization might have been made respecting the north side of the great gaps. Failure to discover the ore within a mile and a half south from the Juniata in West Providence township seemed to give the necessary basis for the theory; but the failure to discover ore there has been proved to be due to circumstances other than absence of ore; for ore is present in abundance and in good quality where its absence was asserted as proved by actual and thorough investigation.

In the Cambria mine the ore runs from 2 to 5 feet and from 2 to 4 feet in the Powel mines. Mr. Powel has reached the ore in his Cove tunnel at 240 feet below the outcrop. The following analyses show the variations north from the Juniata river :

- I. Kemble Company's mine at Batesville. McCreath.
- II. Cambria mine in Hopewell township. McCreath.
- III. Stoler farm, Liberty township, *brown hematite*. Britton.
- IV. Cove tunnel, Liberty township. F. A. Genth.

	I.	II.	III.	IV.
Metallic iron,	38.600	55.425	58.12	41.80
Sulphur,	0.018	0.018	0.00	0.00
Phosphorus,	0.213	0.229	0.27	Trace.
Insoluble residue,	30.990	5.740	4.11	35.57
Water,	—	—	11.20	4.24

Another sample from No. 4 showed 44.36 of metallic iron and 0.023 of phosphorus.

The Frankstown bed.

This is about 380 feet below the "*fossil*" bed, but it does not appear so persistently as the other. It certainly exists on the west side of Dunning's mountain in East St. Clair township; on the east slope of Will's mountain in Cumberland Valley township, but it was not seen on the west side of Will's mountain nor does it appear to have been discovered any where in the Black Valley. It has been prospected in St. Clair township for Robert Hare Powel, where its thickness is from 10 to 12 inches; and pits were found at two places in Cumberland Valley township, where, however, its thickness could not be ascertained. Two analyses of this ore have been made by Mr. A. S. McCreath:

- I. L. Geisler farm, East St. Clair township.
- II. M. S. Bortz's farm, Cumberland Valley township.

Metallic iron,	49.550	43.825
Sulphur,	0.017	0.018
Phosphorus,	0.137	0.544
Insoluble residue,	20.530	17.410

It seems to be altogether probable that this bed does not attain economic importance within Bedford county.

The Block Ore.

This lies at the very bottom of the Clinton at approximately 280 feet below the *Frankstown* bed. Proofs of its existence were found on the west side of Dunning's mount-

ain in East St. Clair township; on the east side of Wills and Dunning mountains in Bedford and Cumberland Valley townships; on the west side of Evitts mountain in Bedford township, and on the east side of Tussey mountain in West Providence township. It contains some *fossil* ore in East St. Clair but elsewhere only lumps of *brown hematite* were seen at its horizon. This bed has not been opened at any locality within the district except in West Providence on the Scott and Russell tract, where the thickness is said to be two feet. The quantity of ore appears to be considerable at the head of the Juniata gap through Evitts mountain.

The Clinton ores in Fulton county.

Little is known respecting these ores in Fulton county. There seems to be but one ore horizon along Dickey's mountain and Little Scrub ridge, and that yields an ore of by no means good quality. So far as seen, it is a cellular *brown hematite*, very silicious, and containing not more than 38 per cent. of metallic iron. The ore on Black Log and Shade mountains is *fossil* and is evidently better than the *brown hematite* of Dickey and Little Scrub; but it has not been explored and the thickness of the bed is unknown.

Ores of the Calciferous.

These occur in Colerain, Snake Spring, South Woodberry, Woodberry and Bloomfield townships of Bedford and Ayr township of Fulton.

Within Bedford county these ores do not occur in place but are found in loose sand mingled with fragments of chert and sandstone, the latter coming from the Lower Medina and the Hudson. Fragments of white Medina are common, but those from the other groups predominate. The detrital deposits appear to follow definite lines, forking again and again like water-courses, so as to suggest the possibility of their marking the old drainage lines of the area. These sandy deposits form ridges, known in Morrison's Cove as "barrens." A single ridge only is found in the narrow Friend's Cove, where it is known as Middle ridge.

No development of these ores has been made to any extent within Colerain township and the only one of any importance in Snake Spring is that made by the Kemble Company on J. G. Hartley's property between the Chambersburg pike and the Juniata river. The quantity of ore is considerable but the greater part of it is in small fragments. The existence of ore at many places along this Middle ridge is undoubted, as may be seen by reference to the chapter describing the area between Evitts and Tussey mountains; but no conclusions respecting its quantity would be judicious unless based on actual development far beyond that which has been made.

The most marked line of ore-bearing sands is in South Woodberry and Bloomfield townships. It has been broken badly by erosion, which renders direct tracing not always easy. A sandy ridge can be followed from Beaver creek northward to the line between South Woodberry and Bloomfield, not following the strike of the rocks but bearing almost north and south. Its width is not far from one mile, and its eastern edge passes at somewhat more than a mile and a half west from New Enterprise. There it is narrow owing to erosion by Beaver creek, but it widens northward so as to come very near the road leading through Lafayetteville. As this ridge approaches the northern edge of South Woodberry township it is joined by a similar but narrower ridge, which begins at about a mile west northwest from New Enterprise and continues to its junction with the other at the township line, where the width of the combined ridges is nearly a mile and a half. Thence northward for some distance it becomes narrower, owing to erosion by Yellow creek, but beyond that stream it widens again and is readily traced to Blair county.

The existence of ore along this ridge has been fully proved by prospecting pits and extensive mining operations made by Dr. Schoenberger, the Cambria Iron Company and others at comparatively short intervals. In South Woodberry the ore has been opened on the Ripley and Ebersole properties; in Bloomfield, on the Bender, Stuckey and Longenecker properties south from Yellow creek; while north from that

stream it has been prospected on the Bailey and Long farms, and mined at Baker's Summit and on the Bloomfield property.

Another strip begins in Woodberry near the southern edge of the township between the forks of Yellow creek and goes northward for certainly four miles. The ore is shown on the Hoffman, Fox, Hoover and other farms and, many years ago, mining was done on some of them. The width of this strip was not determined. It is less important than the other.

As these ores are loose, they must be separated from the clay and sand either by screening or washing. Where fragments of chert are not abundant, the ore can be cleaned without difficulty by washing. The process is a simple one. The machinery consists essentially of a trough, 18 inches wide and less than one foot deep; in this revolves a wooden shaft fitted with iron flanges, so arranged as to push the material forward while they agitate it. Water flows through the trough and the finer particles are removed. A more primitive method is to use a hollow wooden cylinder, four or five feet in diameter, fitted with a rim of six inches at each end while small spaces are left between the slats covering the frame. The sand and ore are thrown into the revolving cylinder, the finer particles are washed out through the spaces, while the coarser lumps remain in the box.

The mode in which these ores occur has been described in detail by Mr. Franklin Platt in Report T of this survey. For further description, the reader is referred to that report. Analyses for this report were made as follows by Mr. A. S. McCreath:

- I. J. G. Hartley's ore. Snake Spring township.
- II. Jacob Ripley's ore, South Woodberry township.

	<i>I.</i>	<i>II.</i>
Metallic iron,	57.400	52.750
Sulphur,	0 025	0 026
Phosphorus,	0 119	0.096
Insoluble residue,	4.040	9.910

Unfortunately, these analyses do not represent the shipping ore. They were made from samples obtained by taking chips from piles of ore thrown out from pits and there-

fore freed as far as possible from foreign matter. Despite the utmost precaution, more or less of silicious matter is retained after the washing, so that ore as shipped shows material variations in quality. Analyses made by Mr. A. S. McCreath for the Pennsylvania Steel Company are given in Report T of this survey, and they are reproduced here to show the general character of the ore as shipped :

	<i>Metallic iron.</i>	<i>Phosphorus.</i>
July, 1873,	32.25	0.053
March, 1874,	39.06	0.041
April, 1874,	33.50	0.039
April, 1874,	35.00	0.059
May, 1874,	36.60	0.053

The Calciferous ores are found in McConnell's Cove of Fulton county, where however they occur in place, not in detritus as in Morrison's and Friend's Coves of Bedford county. One great nest of this *brown hematite* supplied the Hanover Iron Works from 1827 until the furnace was blown out in 1847, and clearly the pocket was not exhausted. Mining in a small way was done elsewhere within the Cove, but the Calciferous ores of that region may be regarded as still undeveloped. Only one analysis of these ores was made. The samples were obtained from the old Hanover mines in Ayr township immediately east from Lowrie's knob. The composition is

Metallic iron,	46.100
Sulphur,	0.115
Phosphorus,	0.083
Silicious matter,	21.500

The Quality of the Iron Produced.

At present only the furnaces at Hopewell and Riddlesburg are in blast. That at Hopewell uses charcoal and a mixture of Lower Helderberg and *Fossil* ores. The iron is mostly mill, very little foundry being made. The following analyses are by Mr. McCreath, No. 1 being that of the mill, and No. 2 that of the foundry.

Charcoal Irons from Hopewell Furnace.

	1.	2.
Silicon,	1.960	1.708
Sulphur,	trace.	0.026
Phosphorus,	0.507	0.429

The Riddleburg furnaces use coke as the fuel and have no ores aside from those of the Clinton. For sometime they have been producing only foundry iron. But formerly mill iron of excellent quality was made. Five tons of it were tested by Messrs. Marshall, Phillips & Co. of Philadelphia and manufactured by them into bar and sheet iron. Their report was as follows:

“The bar iron, when bent hot or cold, showed no indications whatever of a fracture in the fiber; in fact, the best judges could have been deceived as to the hot and cold ends of the bar.”

Samples of the mill and foundry iron made from *fossil* ores during the past year were analyzed by Mr. McCreath, with the following results, No. 1 being the mill, and No. 2 the foundry:

	1.	2.
Silicon,	2.450	1.773
Sulphur,	trace.	0.170
Phosphorus,	0.661	0.625

The hematites of the Lower Silurian are no longer reduced within this district and the whole product of the Bloomfield mines is shipped elsewhere. The Rodman furnaces on the Bloomfield estate used these ores exclusively, with Connellsville coke as the fuel and Trenton limestone as the flux. The metal was used by the Pennsylvania Steel Works, where Mr. McCreath made the following analyses, which are reproduced from Mr. Platt's Report T:

	1.	2.	3.
Silicon,	4.004	3.184	2.713
Sulphur,	0.035	0.082	0.123
Phosphorus,	0.195	0.195	0.192
Manganese,	—	0.144	0.864

No. 1 was made in 1872, No. 2 in March, 1874, and No. 3 in May, 1874. This metal was used with other brands in the manufacture of Bessemer steel.

The charcoal irons made at the old Bloomfield furnace from these ores were so superior "that after a long and complete series of tests, the Bloomfield pig metal was chosen by Capt. Rodman for use in making the heavy ordnance for the United States Government; and he strongly urged that the Government should purchase the whole Bloomfield ore deposit and thus procure a permanent supply of this valuable ore."*

The McConnell's Cove ore appears to have yielded a pig metal not inferior to that of Bloomfield furnace, for by far the greater part of the product of the Hanover Iron Works was taken to the Government Arsenal at Harper's Ferry.

* Report T, p. 219.

CHAPTER XVI.

Limestone; building material; fireclay; timber.

Limestone.

Limestone occurs in many portions of the district and at several horizons. The only bed in the *coal measures* belongs to the upper division of that series and its area is very small. Some beds occur in the lower part of the Mauch Chunk. The gray beds are silicious but yield a lime which answers well for agricultural purposes. It is thought to be better than that from the red limestone of the same group, which, according to Mr. Kelly, of the Kemble Coal and Iron Company, has the following composition :

Carbonate of lime,	69.55
Insoluble matter,	23.00
Metallic iron,	5.00

Limestone is wholly absent from the Pocono and Catskill, unless the Silicious limestone of the south-west part of the district be referred to the former series. Thin beds, 2 to 4 inches thick are found at the base of the Hamilton but they cannot be quarried to advantage.

The Lower Helderberg is by far the most available source of limestone for a great part of Bedford and eastern Fulton. The best material is obtained from the massive beds in the upper part of the group, the middle portion being flaggy and usually magnesian, while the lower portion is shaly and very impure. Numerous analyses of the upper limestones were made, as this must afford flux for reduction of the important fossil ores which lie in close proximity to it. The following analyses by Mr. A. S. McCreath, are tabulated for comparison :

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.
I. A. H. Hull, King township, Bedford county.													
II. L. Geisler, East St. Clair township, Bedford county.													
III. A. Stuckey, Napier township, Bedford county.													
IV. Shoemaker & Co., Harrison township, Bedford county.													
V. Willmetto Company, Londonderry township, Bedford county.													
VI. W. Devore, Londonderry township, Bedford county.													
VII. T. Boor & Bros., Cumberland Valley township, Bedford county.													
VIII. Stapleton's quarry, W. Providence township, Bedford county.													
IX. J. Piper, Hopewell township, Bedford county.													
X. Kemble Company's quarry, Liberty township, Bedford county.													
XI. M. & E. Fisher, Bethel township, Fulton county.													
XII. Mrs. Stilwell Johnston, Thompson township, Fulton county.													
XIII. Ephraim Ramsay, Dublin township, Fulton county.													
Carbonate of lime,	90.660	94.107	91.625	92.875	90.589	98.178	91.071	89.635	84.500	96.592	93.117	87.357	91.903
Carbonate of magnesia,	2.542	2.444	1.536	1.891	1.929	1.854	2.543	1.876	10.019	2.459	2.043	2.346	2.043
Oxide of iron and alumina,	0.822	0.240	0.470	0.370	0.590	0.114	0.440	0.610	0.713	0.240	0.600	1.930	0.810
Sulphur,	0.056	0.086	0.012	0.080	0.018	0.020	0.068	0.022	0.062	0.019	0.075	0.020	0.201
Phosphorus,	0.008	0.010	0.008	0.005	0.005	0.007	0.006	0.005	0.012	0.008	0.006	0.002	0.004
Insoluble residue,	6.250	2.750	6.330	4.810	6.410	0.230	5.590	6.830	4.820	0.930	4.110	8.430	5.550

The great variations shown by these analyses is owing merely to petty intervals. As good limestone as No. X or No. VI occurs at the Willmetto quarries, but the blue limestone was shipped at the time of examination and samples were taken from it rather than from the gray limestone, which is shown there as distinctly as at the Devore quarry. The gray limestone makes an almost white lime, while that from all the others is dull in color. The Willmetto, Peerless and Kemble Coal and Iron Company's quarries were the only ones worked to procure limestone for furnace use, but, no doubt, others will be opened before long in Londonderry and Liberty townships, as there the railroads make the beds readily accessible. All the other quarries are worked merely to supply local kilns whose product is used almost wholly for agricultural purposes. The lime is strong and admirable for building.

Ruschabarger & Co. crush and grind the Lower Helderberg limestone at Hyndman to prepare it for farmer's use. The capacity of the works is from four to five tons *per diem*, and the product finds a ready market. The price is said to be five dollars per ton delivered on board cars, which seems to be an extraordinary price, when burned lime, so much more useful, can be had for much less money.

The Lower Silurian limestones show very decided variations in quality, many of the beds being highly magnesian. The uncertainties in this series are well illustrated by a long series of analyses made from the exposures near Harrisburg and published in Report MM of this survey. The following analyses of the limestones in this district were made by Mr. A. S. McCreath:

- I. D. F. Koons, Colerain twp., Bedford county.
- II. D. Dunkle, Snake Spring twp., Bedford county.
- III. M. Kagarise, S. Woodberry twp., Bedford county.
- IV. J. Brumbaugh, S. Woodberry twp., Bedford county.
- V. J. Carper, Woodberry twp., Bedford county.
- VI. John Sowers, Ayr twp., Fulton county.
- VII. Greathead's quarry, McConnellsburg, Fulton county.

	<i>I.</i>	<i>II.</i>	<i>III.</i>	<i>IV.</i>	<i>V.</i>	<i>VI.</i>	<i>VII.</i>
Carbonate of lime, .	51.964	85.892	90.857	93.014	69.107	76.964	51.143
Carbonate of magnes- ia,	40.032	10.637	3.216	3.329	23.951	19.327	39.301
Oxide of iron and alumina,	1.270	0.410	0.360	0.394	0.542	0.840	0.660
Sulphur,	0.016	0.075	0.103	0.046	0.266	0.140	0.207
Phosphorus, . . .	0.004	0.005	0.006	0.002	0.008	0.005	0.003
Insoluble residue,	6.420	3.090	5.130	3.660	5.790	2.820	9.040

All of these quarries are worked to procure lime for agricultural purposes, no rock being shipped for furnace uses.

Building Materials.

Timber is so plentiful that few houses are constructed of stone. The Lower Silurian limestones are used somewhat in the localities where they occur and they answer admirably, being durable and of good color. Excellent sandstone can be obtained from the Pocono, Portage, and Medina, but the Medina is very hard to dress. The Portage flags break out nicely and are easily trimmed but they, like the lower Medina, though very durable, have a somber tint, which is not altogether agreeable. The Oriskany is used occasionally, but care must be used in selecting the stone as many parts of the group do not resist the weather.

Clay for the manufacture of ordinary brick can be obtained from the sub-soil everywhere within the district.

Fire-clay.

No good plastic fire-clay was seen in the Broad Top region, there being a considerable amount of oxide of iron in all the beds. Nor does the hard clay appear to be present there, no fragments of it having been seen at any locality, though its horizon in the Pottsville is exposed at many localities.

The Savage Mountain fire-clay reaches the south-west corner of Bedford county in Londonderry township. No exposures of it were found within the district, but an extensive mine has been opened on the Baltimore and Ohio railroad in Somerset county just beyond the line of Bedford county. There the clay is mined for the Savage Fire-Brick Company which has works at Hyndman in Bedford

county and at Keystone Junction in Somerset county. The thickness of the deposit varies from nothing to 21 feet, a room with the latter thickness having been reached since the examination was made. Much of the clay makes only bricks of the second grade, but fully one half of the ordinary run and the whole of the mass in the present workings makes bricks of the first quality. This clay has been analyzed by Mr. Otto Wuth of Pittsburgh, who reports its composition as follows :

	No. 1.	No. 2.
Water at 230° F.,	14.02	13.02
Silicic acid,	54.65	55.21
Alumina,	30.74	31.18
Peroxide of iron, . . . . .	.08	.07
Lime, . . . . .	.19	.18
Magnesia, . . . . .	.13	.11
Alkalies, . . . . .	.11	.23
Organic matter and loss, . . . . .	.00	.23

The capacity of the works at Hyndman is 4,000,000 of bricks per annum and their product has been continually sold ahead. The Savage Mountain bricks are believed to be equal to any made in the country and they are widely used in the construction of coke ovens and in lining furnace stacks. It is possible that the high reputation is due quite as much to care in selecting the clay as to the general character of the clay itself.

Timber.

Much of the district is uncleared, but over a great part of the area the choicer trees have been culled, so that the original forest has practically disappeared. Oaks, chestnut, pine, and spruce are shown on the mountain ridges, on the lower hills and in swales are found maples and poplars, while still lower are walnut, hickory and ash, with here and there some gum, cucumber and butternut.

Oaks grow luxuriantly on Medina, Oriskany and Portage ; pines and spruces grow with equal luxuriance on Catskill and Mauch Chunk ; while both oaks and pines thrive well on the Pocono soils. Eastern Bedford and western Fulton still contain much excellent pine timber, many trees of nearly two feet diameter having been seen. But the many

saw-mills are fast utilizing the larger trees, so that within a very few years, prime lumber will be an insignificant item in the list of products. Oaks are rapidly disappearing to supply ties to the railroads and bark to the tanneries, while, in much of the district, forest fires effectually destroy the young trees.

Chestnut, maple and poplar are still in sufficient quantity to be important. Chestnut abounds on the limestone ridges. The other woods, previously mentioned, are found only in small quantities. The supply of black walnut timber has become insufficient everywhere in our country and farmers would do well to plant walnut trees. There are extended strips of rich bottom land in both Fulton and Bedford which are too stony for cultivation, but which would answer admirably for walnut, hickory and ash.

Chestnut oak is abundant in the region lying west from Wills-Dunning mountain, and it is present in the Catskill swales along the foot of the Allegheny mountain. A great quantity remains on both sides of Evitts and Tussey mountains, and much remains untouched along Ray's hill; Side-ling hill and Whip cove still have a large amount available.

The abundance of this timber led to the establishment of tanneries at many places in both Bedford and Fulton, and extensive tanneries are now in operation at Pleasantville, Mann's Choice, Rainsburg, Everett, and Fairview, in Bedford county; at Franklin Mills, Well's Tannery post-office, Saluvia, and McConnell's Cove, in Fulton. A large tannery was operated for many years at Emmaville in Fulton county, but it exhausted the supply of bark and was removed some years ago.

The amount of bark consumed is enormous; the larger tanneries of Bedford county use about 17,000 cords per annum, and those of Fulton county about 4,500 cords. Besides these, there are many small tanneries in both counties, while a very large one in Maryland, on Flintstone creek, draws much of its supply from Bean's Cove and Black Valley.

If protected from fires, the young chestnut oaks are ready for stripping in twenty years; but forest fires usually de-

stroy the saplings, so that in many localities, where the tree was once abundant, there are now only pines and scrubby oaks.

CHAPTER XVII.

Mineral Springs.

Bedford Springs.

These are at barely a mile and a half south from the courthouse in Bedford borough, and the altitude of the little valley in which they are found is not far from 1100 feet above tide. According to Gordon, the medicinal value of these springs was discovered in 1804 by a mechanic of Bedford, who, while fishing in Schober's creek near the large spring, drank freely of the water flowing from the bank. This proved purgative and sudorific. He had suffered for many years from rheumatic pains and from severe ulcers on the legs. The comfort resulting from the first use of the water led him to drink it and to bathe in it daily. A cure resulted within a few weeks. Others learning of this incident came to the springs for relief, and the summer of 1805 brought many who were suffering from chronic diseases. Since that time the Bedford Springs have been a summer resort for great numbers, both of the sick and the well. Nature has done much to render the place attractive and a judicious expenditure of a comparatively small amount of money would make it as charming as could be desired.

The important spring of the series, medicinally considered, is the Magnesia Spring. According to the analysis of Dr. F. A. Genth, the composition of the water is as follows :

The Magnesia Spring.

One gallon of 231 cubic inches contains

	<i>Grains.</i>
Carbonate of calcium,	10.43268
Carbonate of magnesium,	0.93729
Carbonate of manganese,	trace.
Carbonate of iron,	0.04248
Sulphate of barium,	0.00457
Sulphate of strontium,	0.12099
Sulphate of calcium,	99.82985
Sulphate of magnesium,	39.62025
Sulphate of sodium,	0.32925
Sulphate of potassium,	0.17806
Phosphate of calcium,	0.01513
Chloride of sodium,	0.46211
Chloride of lithium,	faint trace.
Silicic acid,	0.77118
Hydrosulphuric acid,	0.00397
Carbonic acid,	0.55808
	<hr/>
	153.30596
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The water of this spring is diuretic and cathartic. It is believed to be useful in chronic liver derangements, dyspepsia, diseases of the kidneys and in cases of general debility following the cure of acute diseases. The water admits of transportation and much is shipped to be drunk by departing visitors.

The Sulphur Spring is nearly 200 yards from the main spring. It exhales a strong odor of hydrosulphuric acid and the flavor is far from being agreeable. The water from this spring has been analyzed by Dr. F. A. Genth with the following results:

The Sulphur Spring.

Temperature of the water,	62.6 F.
Temperature of the air,	67.1 F.

One gallon of 231 cubic inches contains

	<i>Grains.</i>
Carbonate of calcium,	10.21859
Carbonate of magnesium,	0.99376
Carbonate of iron,	0.08189
Carbonate of manganese,	trace.
Sulphate of calcium,	78.08438
Sulphate of magnesium,	33.39402
Sulphate of sodium,	0.51219
Sulphate of potassium,	0.40578
Phosphate of calcium,	0.02177
Chloride of lithium,	faint trace.

Chloride of sodium,	0.36710
Hydrosulphuric acid,	0.08520
Silicic acid,	0.53749
Carbonic acid,	2.79479
	<hr/>
	122.49205
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This spring certainly should be little inferior to the main spring in cathartic properties. The Magnesia Iron Spring is in the immediate vicinity of the last. Its water has been analyzed by Dr. Genth with the following result:

The Magnesia Iron Spring.

Temperature of water,	57.2 F.
Temperature of the air,	67.1 F.

One gallon of 231 cubic inches contains:

	<i>Grains.</i>
Carbonate of calcium,	8.47132
Carbonate of magnesium,	0.59120
Carbonate of iron,	0.04659
Carbonate of manganese,	trace.
Sulphate of strontium,	0.00725
Sulphate of calcium,	90.45513
Sulphate of magnesium,	38.68368
Sulphate of sodium,	0.60824
Sulphate of potassium,	0.29582
Chloride of lithium,	faint trace.
Chloride of sodium,	0.53476
Phosphate of calcium,	0.02248
Hydrosulphuric acid,	0.00596
Silicic acid,	0.16943
Carbonic acid,	1.27347
	<hr/>
	140.56533
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In the vicinity of these springs are several limestone springs one of which is of great volume and is familiarly known as the Large Limestone Spring. Its water has been analyzed by Dr. Genth. Unlike the other springs, it contains a comparatively small amount of saline ingredients. The result of analysis is as follows:

The Large Limestone Spring.

Temperature of water,	51.8 F.
Temperature of air,	66.2 F.

One gallon of 231 cubic inches contains:

	<i>Grains.</i>
Carbonate of calcium,	7.09422
Carbonate of magnesium,	1.87983
Carbonate of iron,	0.03574
Carbonate of manganese,	trace.
Sulphate of strontium,	0.07505
Sulphate of calcium,	0.53840
Sulphate of magnesium,	0.29411
Sulphate of potassium,	0.26815
Phosphate of calcium,	trace.
Chloride of sodium,	0.22805
Chloride of potassium,	0.00384
Hydrosulphuric acid,	0.00496
Silicic acid,	0.46738
Carbonic acid,	3.76742
	<hr/>
	14.71305
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But, at the hotel, is a spring of the purest soft water containing, according to Dr. Genth's analysis, little more than one grain of mineral matter to the gallon of 231 cubic inches. All of these springs, except the sweet or soft water springs, issue from the Lower Helderberg limestone, which forms the cliff-like walls enclosing the narrow valley. A chalybeate spring issues at three fourths of a mile southwest from the hotel. This was not visited, but it evidently comes from the Marcellus shale. Dr. Genth has analyzed the water of this spring also, with the following result:

The Chalybeate Spring.

Temperature of water,	52.7 F.
Temperature of air,	68.0 F.

One gallon of 231 cubic inches contains :

	<i>Grains.</i>
Carbonate of calcium,	8.85143
Carbonate of magnesium,	1.20143
Carbonate of iron,	0.44233
Carbonate of manganese,	trace.
Carbonate of sodium,	0.39499
Carbonate of potassium,	0.13191
Sulphate of calcium,	2.74122
Phosphate of calcium,	0.03336
Chloride of sodium,	0.12025
Hydrosulphuric acid,	0.00298
Silicic acid,	0.79297
Carbonic acid,	5.59575
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	20.30862
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The analyses show that there is no material difference between the water of the Magnesia Spring and that of the Magnesia Iron Spring, although there is supposed to be some healing virtue in the latter, which is not possessed by the former; and that in like manner the Magnesia Spring has some excellence which the Magnesia Iron has not.

The Chalybeate Spring.

This occurs on John Hafer's property north from the Juniata river about a mile north-east from the borough of Bedford. It is a resort for invalids, there being a hotel near by. The water of this spring has been analyzed by Dr. F. A. Genth, with the following result:

One gallon of 231 cubic inches contains as follows:

	<i>Grains.</i>
Sulphate of calcium,	4.40579
Phosphate of calcium,	0.02947
Carbonate of calcium,	11.33768
Carbonate of magnesium,	2.52002
Carbonate of iron,	0.36002
Carbonate of manganese,	0.02051
Carbonate of sodium,	0.74997
Carbonate of potassium,	0.24534
Chloride of sodium,	0.18293
Chloride of lithium,	trace.
Silicic acid,	0.85882
	<u>20.71055</u>

This spring issues from very near the junction of the Oriskany sandstone with the Marcellus shale. The water differs from that of the Bedford Chalybeate in an increased proportion of carbonate of calcium and carbonate of manganese, while sulphate of magnesium is absent and iron is in less proportion. This water contains less of iron than that of the Reed and Lyon White Sulphur Spring.

The Reed and Lyon White Sulphur Spring.

This is in Harrison township within Milligan's Cove and is opposite the gap in Buffalo mountain through which the road leads to Sulphur Spring station on the Bedford railroad. The spring issues from Utica shale. Its volume could not be estimated satisfactorily, as the cistern is a de-

cayed wooden box, which does not retain the water, most of which leaks out and soaks into the soil. The presence of sulphuretted hydrogen is very preceptible. Though small, this spring is in high repute and two small hotels are well filled during the summer season. The water has been analyzed by Dr. F. A. Genth, who gives the following as the composition :

One gallon of 231 cubic inches contains

	<i>Grains.</i>
Carbonate of calcium,	5.58204
Carbonate of magnesium,	1.28822
Carbonate of iron,	0.43345
Carbonate of sodium,	0.54357
Sulphate of calcium,	0.35472
Sulphate of magnesium,	0.98151
Sulphate of sodium,	1.00508
Sulphate of potassium,	0.21628
Phosphate of calcium,	trace.
Chloride of sodium,	0.19256
Chloride of lithium,	trace.
Silicic acid,	1.81111
Hydrosulphuric acid,	0.06425
Carbonic acid,	1.29214
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	18.76498
	<hr/>

This is somewhat weaker in hydrosulphuric acid than the water of the Bedford Sulphur Spring, but it is richer in iron than that or the Chalybeate Springs at Bedford or Hafer's. It contains less of carbonate of lime than the sulphur and chalybeate springs at Bedford and the Hafer spring.

A. M. May's Springs.

These, also in Milligan's cove, at half a mile south from the Reed & Lyon spring, are reputed to be of medicinal value, and the house is well filled with visitors during the summer. The springs issue from Utica shale and are comparatively small. The westerly spring is a White Sulphur, but it seems to contain less of sulphuretted hydrogen than is found in the Reed & Lyon spring. The water is utilized for bathing. It has not been analyzed. The other spring is separated from it by about seven feet and it is supposed to be a chalybeate spring. The water has been analyzed by Dr. F. A. Genth, who gives the composition as follows :

One gallon of 231 cubic inches contains :

	<i>Grains.</i>
Carbonate of calcium,	6.66809
Carbonate of magnesium,	1.18499
Carbonate of iron,	0.05990
Sulphate of calcium,	4.54991
Sulphate of magnesium,	2.24850
Sulphate of sodium,	1.30633
Sulphate of potassium,	0.43648
Phosphate of calcium,	0.05302
Chloride of sodium,	0.46212
Chloride of lithium,	trace.
Silicic acid,	0.83350
Carbonic acid,	5.45504
	<hr/>
	23.25728
	<hr/>

It is difficult to understand what the medicinal qualities of this water are. It differs from that of the large limestone spring at Bedford only in the slightly increased proportion of sulphate of calcium, sulphate of magnesium and carbonic acid. The effective ingredients are present in almost insignificant quantity and the water to all intents and purposes must be inert.

Wolford's White Sulphur Spring.

A small spring was seen alongside of the road below Wolford's gap through Buffalo mountain in Londonderry township. It issues from the Lower Helderberg limestone. The volume is very small and the sulphuretted hydrogen only perceptible. In a general way it resembles the sulphur spring on A. M. May's property. No analysis of the water has been made.

Adams' White Sulphur Springs.

Some white sulphur springs were seen near the east foot of Warrior ridge in Southampton township at about a mile north from Cheneysville. Originally, as reported, there were seventeen outlets within less than one acre of ground ; but nearly all of these are covered with sod. The sulphuretted hydrogen is present in considerable quantity but the volume of the springs now open is not great, though if the water were collected, the volume might prove to be greater than

it appears to be. Many years ago, these springs had a local reputation for efficiency in the cure of scrofula and the itch.

The water was analyzed in 1868 by Dr. W. P. Tonry of Baltimore, but the analysis has not been obtained.

Addison Ridge Chalybeate Springs.

These issue from the upper beds of the Chemung. Four were seen at the east foot of the ridge in Monroe township but none of them has been utilized except for domestic purposes. That on the farm of Job Robinson near Robinsonville is perhaps the greatest in volume and it is one of the best.

CHAPTER XVIII.

Agricultural resources.

Soils.

The soils of this district are of local origin and are due for the most part to decomposition of the rocks on which they lie.

The distribution of *limestone* soils is sufficiently shown on the map by the blue colors assigned to the outcrops and areas of the Lower Helderberg, Trenton and Calciferos limestone groups. They are found in Morrison's and Friend's Coves of Bedford county, in Pigeon and McConnell's Coves of Fulton county. A petty area exists on Chestnut ridge in Bedford.

These soils invited the earliest settlers, so that they have been long under cultivation. Little woodland remains in any of the coves, except along the borders, where sandstone debris covers the surface and renders farming difficult. In Morrison's Cove, the "barrens" or ridges covered by loose clay and sand have still much timber.

There seems to be but little difference in point of fertility between soils derived from the Lower Helderberg and those derived from the Trenton or Calciferous. On all, the farming has been exhaustive for nearly one hundred years and the crops are now much less than they should be. In Morrison's Cove the yield in an ordinary year is, per acre :

Wheat,	20 bushels.
Corn,	100 bushels of ears.
Oats,	35 bushels.

The yield in McConnell's cove is approximately the same and good farms on the Lower Helderberg soil of Pigeon cove give equally good results. At all localities the crops are

much smaller than they were fifty years ago. The land is limed heavily, but a large proportion of the farmers fail to appreciate properly the necessity of other amendments, so that the soil is forced.

Calcareous soils of mixed origin occur along the foot of Wills and Dunnings mountains ; in the Bedford basin ; and along the east foot of Tussey mountain in Bedford county ; along the foot of Shade, Black Log and Dickey's mountains, and Little Scrub ridge in Fulton county. The soils at these localities are composed of material derived from Medina, Clinton, Lower Helderberg and Oriskany. The mixture of sands renders these less heavy and pasty than the more distinctively lime soils of the coves, but their fertility is less durable, more care being required to keep the farms in good condition.

The wheat yield per acre in Black valley varies from 12 to 18 bushels, corn from 35 to 60 bushels of ears, oats from 20 to 25 bushels ; in Bean's cove, the wheat crop is from 8 to 15 bushels, and that of oats from 20 to 40 bushels ; very little corn is raised. The valleys along Shade and Black Log mountains in Fulton county show a somewhat better yield, probably because of more careful cultivation.

These mixed soils produce much good timber. Black walnut is plentiful on the flats and in the lower part of swales extending into the ridges ; maples are large near the streams, while much oak, hickory and linn was found somewhat higher up.

The *shale* or *slate* soils rest on Mauch Chunk, Devonian, Utica and Hudson outcrops. They show much variation in quality.

Mauch Chunk soils occupy Wells and Brush Creek valleys in Fulton county. Some thin irregular limestone beds occur towards the bottom of the group, but the great mass consists of red clay shale or clayey sandstone, which breaks up readily under the influence of the weather and forms an excellent soil. It is always mixed to some extent with sand from the Pocono rocks which inclose these valleys.

In fair ordinary seasons the soil of Wells valley produces 18 to 20 bushels of wheat, 100 bushels of corn in ears, and

25 bushels of oats. In exceptional years, some farmers have obtained 40 bushels of wheat per acre. The land in Brush Creek valley has been farmed somewhat recklessly, so that much of it is exhausted and yields only from 5 to 8 bushels of wheat per acre or barely 50 bushels of corn in ears. But it is readily improved by liming so as to yield from 15 to 20 bushels of wheat or 100 bushels of corn in ears. The oat crop on such soil is not far from 30 bushels. Limestone is obtained easily in both valleys.

Mauch Chunk red shale is the immediately underlying rock in Sherman or Ground Hog valley of Bedford county and in the Meadow Ground of Fulton county, but at both localities the Pocono débris is very coarse and covers so much of the valleys as to detract greatly from their value. Mauch Chunk soils produce much pine with some white and rock oak.

Soils derived from Catskill rocks are fairly good, as those rocks disintegrate readily and form a fine though somewhat sandy soil. The Chemung beds above the *upper conglomerate* are equally good. Where lime can be obtained without difficulty as in Dublin and Thompson townships of Fulton county, these "red slate" soils are easily rendered productive, lime being apparently the chief amendment needed; but elsewhere the crops are poor. Wheat yields from 10 to 20 bushels, corn from 50 to 75 bushels of ears, and oats from 20 to 25 bushels on unlimed and limed soils respectively. These soils carry rock oak, poplar, white oak, walnut, and abundance of pine.

The lower Devonian rocks do not give good soils. The shales are fissile and the sandstones tough, so that disintegration is ordinarily slow. On some farms that have been cultivated for nearly 100 years, the soil is so thin that clover will not take good hold. Lime is of no little service, but its effects are far from being so marked as on Catskill soils. Bone dust acts admirably for two or three seasons.

Soils of this character prevail east from Warrior Ridge in West Providence, Monroe, and Southampton townships, where wheat yields from 7 to 10 bushels, corn 30 to 50 bushels of ears, and oats 10 to 20 bushels; in Thompson,

Belfast, and Licking Creek townships of Fulton county wheat gives from 7 to 10 bushels, corn 20 to 40 bushels of ears, oats 15 bushels, and rye 10 to 12 bushels per acre. On new land, wheat yields 20 bushels for two or three years, and in a few instances, 30 bushels have been obtained. Better crops are obtained west from Wills mountain in Londonderry and Harrison townships of Bedford county, where the Lower Helderberg limestone is within easy reach. Though unprofitable when sown in grain, these soils yield large crops of excellent potatoes and are well adapted to fruit-raising. White and red oak, maple, chestnut, and beech thrive on them.

The Hudson and Utica shales, like the Hamilton, disintegrate slowly and give a soil which is thin and far from productive. That of Milligan's Cove in Bedford county yields only 10 bushels of wheat and 20 bushels of oats.

The greater part of the *sandstone* area is practically worthless for agricultural purposes. The Medina resists the weather and the slopes of its ridges are covered with angular fragments, which make plowing impossible. On some ridges, the Oriskany and Pocono have yielded to the weather so as to break down into fine sand, which is rich in vegetable matter derived from decaying leaves. Some very fair farms were seen on the Bedford pike and the Old State road between Ray's hill and Sideling hill, where only Pocono sandstone underlies the surface. These are said to yield much better crops than can be obtained from Chemung or Hamilton shales, when no lime is used. New ground yields nearly 30 bushels of wheat per acre.

Water.

Though streams flowing across the Devonian beds are liable to become very low during prolonged drouth, yet, as was proved during the excessively dry season of 1881, there is at most localities an ample supply of water for domestic use and for cattle. Springs occur abundantly and many of them, especially those in limestone regions or their vicinity, are of great size. Those at Spring Hope, Spring Meadow,

Bedford Springs, and McConnell's Cove have volume to run large mills.

The fall in the stream is rapid but mostly regular. Variations in the rate depend upon changes in the rock. The alternations of shale and sandstone in the several series make Brush, Licking, and Tonoloway creeks important sources of power. The numerous forks of Dunnings, Bobbs, and Georges creeks afford excellent mill sites at the mouths of their gaps through the *Chemung conglomerate* ridge.

Outlets to Market.

The southern townships of Bedford and Fulton counties are within a short distance of the Baltimore and Ohio railroad in Maryland. As the drainage is southward in those townships, that railroad can be reached easily.

An outlet for the greater part of Bedford county is afforded by the Bedford railroad and the Huntingdon and Broad Top railroad, which form a continuous line from the southern to the northern border of the county. The easterly flow of the streams in most of the area west from Wills and Dunnings mountains makes this road readily available for all that area, except the extreme north-west corner. In like manner the road is reached easily from all parts of the area lying east from Tussey mountain. Morrison's Cove is touched at the northern edge of the county by two branches of the Pennsylvania railroad. There is but a small part of the county lying at more than fifteen miles from a railroad station.

The greater part of Fulton county is without railroad facilities. The Mercersburg branch of the Cumberland Valley railroad almost touches its eastern border, but the bold Tuscarora mountain forms a serious barrier. It is confidently expected that a railroad will be constructed across the county within two years.



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